ID: SP01	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Using Vibrational Speakers in Adaptive Active Sound Control System for Urban Noise Mitigation
Summary (200 – 400 words)	Urban noise pollution is a persistent challenge in high-density cities, where the need for natural ventilation through windows often conflicts with the desire for a quiet indoor environment. Traditional passive approaches such as thick glazing or physical barriers are often bulky, costly, and impractical for residential or retrofit applications. Active Noise Control (ANC) offers a promising alternative by using electroacoustic techniques to generate anti-noise signals that effectively cancel unwanted sounds in real time. This project aims to design and implement an adaptive active sound control system that employs vibrational speakers positioned near common noise entry points—such as window frames—to reduce intrusive urban noise. Unlike conventional loudspeakers, vibrational speakers can directly excite panels or mounting surfaces, enabling discreet integration and potentially improved energy efficiency. In addition, the system will explore adaptive signal-processing techniques, with the option to incorporate machine-learning methods, to enhance performance under varying noise conditions. The **project scope** includes: (1) Literature review on active noise control techniques and the use of vibrational speakers in applications.; (2) Developing hardware subsystems, including microphones, vibrational speakers and microprocessor platforms (3) Developing software modules for real-time adaptive filtering and exploring machine learning data-driven enhancements to improve cancellation performance. (4) Integrating and evaluating the complete system through controlled experiments that simulate typical urban noise profiles. Students are expected to develop the following skills (**learning outcome**): (1) To understand electroacoustic principles and urban noise characteristics; (2) To be familiar with hardware and software integration into a functional testable prototype; (3) To be familiar with real-time signal processing and adaptive algorithms (e.g., LMS filtering) ; The deliverable outcomes by the FYP students are: (1) A working prototype of an active noise control system using vibrational speakers. (2) Software incorporating adaptive or machine-learning-based control strategies. (3) Performance evaluation reports demonstrating measurable noise reduction. **Prerequisite:** Comfortable with learning signal processing, microcontroller programming, python programming, and hardware–software integration.
Student Workload Distribution	Student 1: Hardware development, vibrational speaker integration, microphone array design, and mechanical setup.
	Student 2: Software development, real-time signal processing and algorithm optimization, data analysis, and performance evaluation.
Supervisor	Chua Dingjuan, elechuad@nus.edu.sg
Laboratory Work	Bench-top instruments (microphones, vibrational speakers, microcontrollers)
No. of students	2
CA1 requirements	A preliminary prototype demonstrating basic hardware integration and real-time noise cancellation in a simplified test scenario.
CA2 requirements	Integrated adaptive active sound control system with vibrational speakers and a comprehensive working demonstration under realistic noise conditions.

ID: SP02	This FYP proposal is for 3+1+1 students at NUSRI Suzhou
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Development of Satellite Collision Monitoring Software
Summary (200 – 400 words)	With the increasing number of satellites being launched into low Earth orbit (LEO), the risk of orbital collisions has significantly grown. The Satellite Technology and Research (STAR) Centre successfully launched the 18 kg satellite Lumelite-4 in April 2023. However, the satellite has been receiving at least six collision warnings per month. To address this growing risk, the STAR Centre intends to develop an in-house satellite collision monitoring system that supports collision mitigation planning. In addition, the STAR centre will launch three satellites in late 2025. Two of the satellites are equipped with a propulsion system, enabling them to actively perform collision avoidance maneuver. Hence, it is crucial to have such monitoring and early warning system that enable an effective collision avoidance maneuver's execution. This project aims to design and develop a Python-based graphical user interface (GUI) for the in-house built satellite collision monitoring system. A preliminary python-based satellite collision monitoring system has been previously developed, but with limited functionality. This project will further enhance such system by integrating collision probability analysis at each predicted conjunction and enabling maneuver input for mitigation analysis. In addition, GUI will allow the user to visualize all the possible collision events with respect to selected satellites. Real satellite data will be used to validate the system's performance. **The project scope includes:** **(1) Literature review of orbital mechanics of satellite;** **(2) Literature review of coordinate transformation;** **(3) Literature review on integration techniques;** **(4) Review the work done under past FYP projects;** **(5) To design and develop the python-based GUI, and** **(6) Implement the two-dimensional probability analysis.** Students are expected to develop the following skills (learning outcome): (4) To understand the orbital mechanics; (5) To understand the basic of coordinate transformation; (6) To be skilled at python programming, and (7) To be skilled at data analysis. The deliverable outcomes by the FYP students are: (1) To design the python-based GUI for satellite collision monitoring system; (2) To implement the collision probability analysis for each possible collision risk; (3) To integrate satellite maneuver profile for collision mitigation analysis purpose, and (4) To test and validate the satellite collision monitoring system with real satellite data. **Prerequisite:** Python knowledge is a must. Matlab knowledge is essential.
Student Workload Distribution	Student 1: On python-based graphic user interface (GUI) development. Integrate the past python code into developed GUI.
	Student 2: On develop the two-dimensional collision probability analysis and integrate the satellite maneuver profile into the system.
Supervisor	GOH Shu Ting, shuting@nus.edu.sg
Laboratory Work	Computer
No. of students	2
CA1 requirements	Basic design of GUI with partial interactable feature. Code based demonstration for collision probability and satellite maneuver profile analysis.
CA2 requirements	Fully interactable GUI. Collision risk and collision probability can be display on GUI. Allow user to input satellite maneuver profile for collision mitigation analysis.

ID: SP03	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Simulation and Understanding of Advanced Transistors Employing High Mobility Channels for Future High Performance Computing
Summary (200 – 400 words)	We are approaching the end of Moore's law and the transistor gate length has scaled to less than 20 nm. Extensive research efforts have been made to use high mobility channel materials to further push the device performance for future high-performance and low-power logic applications as well as ultra-high frequency RF applications. Several promising channel materials have been proposed, such as strained Si, SiGe, Ge, etc. This project aims to simulate, understand, and analyze the electrical characteristics of advanced transistors employing high mobility channel materials, such as strained Si and Ge. The project scope includes: (1) To understand the physics of advanced transistors by literature review (2) To simulate some basic electrical characteristics of strained Si or Ge-based transistors using TCAD (3) To analyse the current-voltage performance of the transistors, including the drive current, trans-conductance, contact resistance, etc (4) To analyse the capacitance-voltage performance of the advanced transistors Through this project, students are expected to develop the following skills (learning outcome): (1) To understand basic knowledge and device physics of advanced transistors (2) To learn Matlab programming (3) To lean TCAD simulation such as Sentaurus (4) To extract various key device parameters and provide guidance for further experiment to improve the device performance (5) To write good technical reports and possibly submit papers to international conferences or journals. The deliverable outcomes by the FYP students are: (1) To be skilled at Matlab programming for data processing (2) To be skilled at Sentaurus TCAD simulation (3) To obtain the I-V and C-V electrical characteristics with various device structures and dimensions (4) To extract various key device parameters that are strongly correlated to the electrical performance of the transistors, such as mobility and guide future experiments to achieve better device performance.
Student Workload Distribution	Student 1: Simulation and analysis of strained Si channel devices Student 2: Simulation and analysis of Ge channel devices
Supervisor	Gong Xiao; elegong@nus.edu.sg
Laboratory Work	Matlab, TCAD such as Sentaurus
No. of students	2
CA1 requirements	Literature review and simulation of the electrical characteristics of long channel transistors using TCAD.
CA2 requirements	Simulation of the electrical characteristics of short channel transistors with advanced device structures using TCAD

ID: SP04	This FYP proposal is for 3+1+1 students at NUSRI Suzhou
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Aggregate Bands FMCW based on Injection Locked Oscillator
Summary (200 – 400 words)	FMCW radar is popular for ranging and localization applications. However, the resolution is highly dependent on the bandwidth. Conventionally, it is difficult to implement wideband FCMW due to the VCO bandwidth limitation. In this project, we are looking at combining a few injection-locked based VCOs at multiple carrier frequency. In combination, they can achieve an aggregate bandwidth of an equivalent wideband FMCW while eliminating the bandwidth limitation of VCO. The **project scope** includes: (1) Literature review of various FMCW architecture; (2) Design and simulate the injection locked oscillator; (3) Combine at least two injection locked oscillator to implement the aggregate bandwidth FMCW; (4) Evaluate the performance and benchmarked with other FMCW design; Students are expected to develop the following skills (**learning outcome**): (1) To understand the FMCW principle; (2) To develop EDA tool usage skillset; (3) To develop schematic design and circuit simulation skill; (4) To be able to evaluate FMCW transmitter performance; The achievable outcomes by the FYP students are: (1) A completed aggregate band FMCW architecture containing detailed transistor level schematic; (2) A complete simulation results to evaluate the FMCW transmitter performance. **Prior experience of software and hardware implementation is a must.** If there are two students to work on the project, each student should carry out different design, and achieve the above-mentioned outcomes. **Prerequisite:** Prior experience of EDA, such as cadence, is a must.
Student Workload Distribution	Student 1: Work on the FMCW transmitter centres at X-band
	Student 2: Work on the FMCW transmitter centres at K-band
Supervisor	Heng Chun Huat, elehch@nus.edu.sg
Laboratory Work	Not applicable
No. of students	2
CA1 requirements	Review of FMCW architecture and injection locked based oscillator
CA2 requirements	Implementing the aggregate band FMCW transmitter

ID: SP05	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Exceptional point topological circuits for sensing applications
Summary (200 – 400 words)	In this project, students will analyze topolectrical (TE) circuits with PT (parity-time) symmetry and possessing at least an exceptional point (EP). An exceptional point is a transition point which leads to very high sensitivity. The objective is to model, design, optimize and finally implement EP circuits with high sensitivity, Q-factor and low noise. The students will design and characterize realistic EP circuits using the LTspice library which incorporates parasitic components as well as tolerance range of normally available circuit components. The project scope includes: i) Literature review of research articles covering TE circuits ii) Apply Kirchhoff's laws to verify the analogy between the output of TE circuits and the corresponding Hamiltonian of quantum systems iii) Study non-Hermitian TE circuits and the PT symmetry of such circuits iv) Study the transition of such circuits at the EP points. v) Modelling of the TE circuits with circuit simulation software e.g. LTspice. vi) Study and optimize the eigenspectrum of the TE circuits under different PT symmetry vii) Study and quantify the sensitivity of the EP circuit Students are expected to develop the following skills (learning outcome): i) Realistic circuit simulations using simulation packages such as LTspice ii) Analytical and numerical programming skills with Mathematica or Matlab iii) Able to design and implement INIC which is required for non-Hermiticity and gainy/lossy behaviour. iv) Able to design and analyze PT symmetry-based TE circuits v) Able to design the PCB of PT symmetry based TE circuit for sensing application The deliverable outcome by the FYP students for the CA assessment are: i) General design and characterization of EP-based TE circuits ii) Actual PCB design and implementation of EP-based TE circuits If there are two students to work on the project, each student should take charge of different aspects of the circuit design, PCB design and circuit implementation.
Student Workload Distribution	Student 1: On theory and circuit design, circuit characterization
	Student 2: On circuit simulation, PCB design, circuit implementation
Supervisor	Mansoor Bin Abdul Jalil
Laboratory Work	Matlab, Mathematica and LTspice software, PCB design and circuit characterization
No. of students	2 (not more than 2 students for each project)
CA1 requirements	General theory and implementation of basic TE circuits
CA2 requirements	To achieve the goals set out in Deliverables (i) and (ii).

ID: SP06	This FYP proposal is for 3+1+1 students at NUSRI Suzhou
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Surgical World Model for AI-Enabled Portable Robotic Surgery
Summary (200 – 400 words)	With the intention to advance simulation capabilities for surgical robots, we propose a high-fidelity Surgical World Model (SWM) that replicates realistic instrument–tissue interactions and generates controllable surgical video sequences from instrument actions. This project aims to build a unified software system combining 3D Gaussian Splatting–based instrument reconstruction with action-guided diffusion video generation to produce high-fidelity synthetic datasets for surgical robot learning. Compared with conventional simulators, the SWM will enable scalable training with realistic soft tissue dynamics, supporting multiple exercises and improving transferability to real surgical environments. The project scope includes: (1) Literature review of surgical simulation, world models, and diffusion-based video generation in robotics; (2) Instrument reconstruction and action estimation using a Real-to-Sim pipeline based on 3D Gaussian Splatting (GS) to create controllable digital twins from surgical videos; (3) Action-guided diffusion modelling to generate surgical scene frames conditioned on instrument pose, tissue state, and context masks; (4) Integration of the GS-based reconstruction and action-guided diffusion model into a unified SWM pipeline for dataset generation. Students are expected to develop the following skills (learning outcomes): (1) To understand the principles of world models and their application in AI for surgery; (2) To be familiar with data processing, including RGB-D videos and surgical kinematics; (3) To be skilled at 3D reconstruction using Gaussian Splatting; (4) To be skilled at training and fine-tuning diffusion-based video generation models. The deliverable outcomes by the FYP students are: (1) A working prototype of a Surgical World Model capable of generating instrument-tissue interaction sequences from action inputs; (2) A controllable 3D digital twin pipeline for surgical instruments; (3) A dataset of synthetic instrument–tissue interaction pairs for robotic policy learning; (4) An evaluation of the generated dataset for consistency against real surgical videos. **Prerequisite:** Experience in Python programming, computer vision, and deep learning; familiarity with PyTorch and 3D modelling is preferred.
Student Workload Distribution	Student 1: on instrument reconstruction and action estimation, including developing the Real-to-Sim pipeline, implementing 3D Gaussian Splatting for instrument modelling, and building the mechanical/virtual calibration setup for aligning video data with reconstructed models.
	Student 2: on action-guided diffusion video generation and system integration, including training the diffusion-based Surgical World Model, developing the interface to control video generation from instrument action sequences, and performing dataset evaluation and analysis for realism and consistency.
Supervisor	Yueming Jin, ymjin@nus.edu.sg
Laboratory Work	Computer
No. of students	2
CA1 requirements	Basic prototype of the Surgical World Model with 3D Gaussian Splatting reconstruction from a short surgical video and initial action estimation. Simple demo of instrument movement in a static scene.
CA2 requirements	Complete Surgical World Model with integrated reconstruction, action-guided diffusion generation, and controllable dataset output. Full demo showing realistic instrument–tissue interaction from action inputs, with evaluation results.

ID: SP07	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Development of Self-Powered Sensors and Self-Sustained Systems for Plant Monitoring
Summary (200 – 400 words)	With climate-resilient agriculture becoming urgent, real-time monitoring of plant physiology (e.g. stem growth, leaf turgor, surface temperature, humidity) is essential for precision irrigation, nutrient optimisation and early-stress detection. However, thousands of nodes scattered across a greenhouse or open field cannot rely indefinitely on disposable batteries. This project needs FYP students to create self-powered, self-sustained plant sensing systems that can harvest ambient energy while collecting and wirelessly transmitting data. Students will design and fabricate triboelectric-nanogenerator (TENG)–based devices for either self-powered sensing or energy harvesting and integrate commercial low-power IoT sensors with them to realize self-sustained monitoring systems. The **project scope** includes: 1) Literature review on plant-attachable self-powered sensors and relative monitoring systems, TENG energy harvesters and self-sustained IoT systems. 2) Selection / fabrication of flexible self-powered sensors. 3) Characterisation of energy harvesters (wind-, raindrop- or vibration-driven) and power-management circuitry. 4) System integration: energy harvester → power-conditioning → sensor node → BLE/WIFI data link. Students are expected to develop the following skills (**learning outcome**): 1) Understand materials, designs and working mechanisms of TENG-based self-powered sensors & energy harvesters. 2) Gain hands-on skills in flexible electronics prototyping and basic micro-controller programming. 3) Acquire experience with power-budget analysis and low-power wireless communication. 4) Develop competence in experimental design, data acquisition and result interpretation. The deliverable outcomes by the FYP students are: 1) A dataset of performance tests: harvested power vs. load, run-time, and sensor performance. 2) A concise optimisation report showing how test data guided improvements to the design. 3) A working self-sustained system that meets basic functional requirements (sensing + wireless on harvested power). **Prerequisite:** Prior experience of basic electronics is a must. Sensor or device fabrication through 3D printing is recommended.
Student Workload Distribution	Student 1: fabrication and characterisation of self-powered sensors; integration of IoT sensors; final self-sustained system testing and data analysis.
	Student 2: design and fabrication of energy harvesters; development of power-management circuitry and low-power wireless communication; assembly of the entire self-sustained system.
Supervisor	Chengkuo Lee, elelc@nus.edu.sg
Laboratory Work	Bench-top instruments, computer, 3D printer, MCU.
No. of students	2
CA1 requirements	Fabrication and basic characterization of the sensor and energy harvester; submission of test data (sensitivity, output power, etc) with brief analysis.

ID: SP08	This FYP proposal is for 3+1+1 students at NUSRI Suzhou
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Developing an Interactive Lower Limb Training Device (walking carpet) for Stepping and Walking exercises
Summary (200 – 400 words)	In order to restore muscle strength, a person with lower limb disability should adhere to regular and intensive rehabilitation exercises, especially visually guided or voice-guided movements. Most of children are very passive when using traditional tools for these repetitive training. With the intention to support training exercises actively, the project is to develop an lower limb rehabilitation device such as the walking carpet, which can guide patients to step and walk. This project aims to design an interactive walking carpet consisting of both hardware and software to motivate children for rehabilitation exercise. Compared with the traditional training methods, the game would enhance the fun of training through interactive forms such as visual feedback and voice instructions. The project scope includes: (1) Literature review of interactive rehab device design and relevant technologies. (2) hardware study using microprocessor to process captured data, sensors to detect motion during arm stretching exercise, wireless communication for data record and storage. (3) Software study with data analysis and game design. (4) Integration of hardware and software for interactive training exercise. The achievable outcomes by the FYP students are: (1) To design games associated with the device to motivate patients for rehabilitation exercise. (2) To enhance the fun of training through interactive forms such as visual feedback and voice instructions. (3) To improve the device design based on user testing. (4) To analyse training data to obtain the performance in rehab exercise. Prior experiences of software and hardware are important. If there are two students to work on the project, each student should carry out different parts, and achieve the mentioned outcomes.
Student Workload Distribution	Student 1: on the device hardware including electronics, interface and microcontroller prpgramming.
	Student 2: Software design the interactive training exercise and provide visual feedback and training statistics.
Supervisor	YC Liang (chii@nus.edu.sg) and J Sun (jie.sun@xjtlu.edu.cn)
Laboratory Work	Bench-top instruments, computer, 3D printer.
No. of students	2
CA1 requirements	Preliminary prototype with hardware and software development
CA2 requirements	Interactive Lower Limb Training Device with hardware and software systems

ID: SP09	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Title of Project	Research and development of deployable antennas for small satellites
Summary (200 – 400 words)	The objective of the project is to research and develop concepts for deployable antennas for application in small satellites. Small satellites typically have a low volume and relatively low weight. At the same time, radio antennas are relatively large for communication and remote sensing applications. To realize applications with such antennas requires the development of antennas that can be compactly stowed and deployed once the small satellite in space. Various concepts have been proposed in literature and this project aims to build and improve on that. The **project scope** includes: (1) Literature review of deployable antennas for small satellites; (2) Review of planar array antennas and parabolic dish antennas; (3) Conceptual design of the innovative deployable antenna; (4) Implementation and demonstration of the design, including deployment mechanism. Students are expected to develop the following skills (**learning outcome**): (8) To understand small satellites and their constraints; (9) To be familiar with planar antennas and parabolic antennas; (10) To be familiar with mechanical design tools and fabrications tools; (11) To be able to develop an innovative deployable antenna concept. The achievable outcomes by the FYP students are: (1) To develop the concept for an innovative, compact, and deployable antenna; (2) To implement the concept as a demonstrator, including the deployment mechanism; **Prior experience of software and hardware implementation is a must.** This project requires two students to work closely together to achieve the outcome.
Student Workload Distribution	Student 1: design and fabrication of the deployable structure
	Student 2: simulation, design, and testing of the antenna
Supervisor	Koen Mouthaan k.mouthaan@nus.edu.sg
Laboratory Work	Bench-top instruments, HFSS antenna simulations
No. of students	2
CA1 requirement	Literature review, development of several competing concepts
CA2 requirement	Selection of the concept, simulation, optimization, and implementation of a demonstrator

ID: SP10	This FYP proposal is for 3+1+1 students at NUSRI Suzhou
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Title of Project	Lego MechaGrid for Studying Power System Dynamics
Summary (200 – 400 words)	An electric power grid is comprised of numerous synchronous generators interconnected to supply electrical loads reliably. However, the concept of grid stability remains abstract and challenging to visualize, especially for the general public. Traditional teaching methods often fail to provide an intuitive grasp of these complex ideas, presenting a significant barrier to the adoption of new technologies within the industry and to the effective training of future engineers. The dynamic behaviour of a synchronous grid closely resembles that of a spring-damper system commonly studied in mechanical engineering. Central to the notion of grid stability is the concept of system inertia, which plays a crucial role in maintaining synchronism among generators, particularly under varying load conditions. This project aims to bridge the gap between theory and practical understanding by demonstrating how inertia influences the synchronization of generators when loads change. Students will engage in hands-on development of governor (speed) controllers and automatic generation control systems using Lego motors and microcontrollers such as Arduino. Through this interactive approach, participants will gain a deeper, more intuitive understanding of power grid stability and control, equipping them with essential skills for the evolving energy sector. The **project scope** includes: (1) Literature review of spring-damper system and power swing equations; (2) Develop numerical models of the desired power grid and generator controllers; (3) Design motors capable of imitating different electric loads, e.g., air conditioning, etc.; (4) Showcase the Lego MechaGrid is capable of maintaining synchronism after network disturbances. Students are expected to develop the following skills (**learning outcome**): (1) To be familiar with synchronous machines; (2) To be familiar with generator control; (3) To become competent in building simulation models in MATLAB/Python; (4) To become competent in programming micro-controller. **Expected deliverables** by the students are: (1) A hardware setup for showcasing the dynamics of droop control in generators, and motors imitating various electric loads. (2) Design experiments to test the impact of varying inertia (by adjusting flywheel mass or motor parameters) on system stability. (3) Demonstrate the Lego MechaGrid (in radial or meshed topology) capable of imitating the stability issues encountered in actual power grids.
Supervisor	Jimmy PENG
Laboratory work	Coding in micro-controller, MATLAB/Python
No. of students	2
CA1 requirement	Validate the performance of Lego generators and loads under closed-loop control.
CA2 requirement	Showcase a working Lego MechaGrid, where each generator is controlled by a micro-controller.

ID: SP11	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	High-Temperature SiC Voltage-fed Dual Active Bridge DC/DC Converter
Summary (200 – 400 words)	Wide band gap (WBG) semiconductor devices are the future of high-density high-efficiency low cost and light wright power electronics. This project aims to analyse and design a voltage-fed DAB dc/dc converter for voltage gain applications. The project includes mathematical analysis, implementation of modulation strategy, design of components, simulation, and hardware development and testing. The **project scope** includes: (1) Literature review of voltage-fed DAB topologies and modulation techniques (2) Differences in the design of Si and SiC based power electronics (3) High-temperature design study for temperature range of 180-200°C (4) Simulation of the converter with SiC parasitic (5) Hardware development and testing Students are expected to develop the following skills (**learning outcome**): (12) To understand wide band gap semiconductor characteristics (13) To be familiar with circuit analysis and programming (14) To be skilled at thermal analysis and design (15) To be skilled at hardware design, development and testing The deliverable outcomes by the FYP students are: (1) To demonstrate learning of thermal design and management for 180-200°C (2) To improve and demonstrate the density, cost, and weight of the converter (3) To enhance the gate driver and operation learning and training at high device switching frequency of SiC devices **Prerequisite:** Prior experience of hardware implementation is required.
Student Workload Distribution	Student 1: on circuit hardware development, thermal analysis, and design with SiC semiconductor devices.
	Student 2: on simulation, modulation implementation through programming, gate driver development. Testing, calculation, and benchmarking will be done together
Supervisor	Akshay Kumar Rathore, akshay.rathore@nus.edu.sg
Laboratory Work	Bench-top instruments, computer, power supplies, logic power supply, meters and scope
No. of students	2
CA1 requirements	Mathematical analysis, circuit design, thermal design, and simulation results
CA2 requirements	Preliminary prototype with hardware and software development. Simple demonstration.

ID: SP12	This FYP proposal is for 3+1+1 students at NUSRI Suzhou
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Optimal Home Energy Management System with Renewable Energy and Storage Integration
Summary (200 – 400 words)	With rising household adoption of renewable energy systems such as rooftop solar and the integration of residential energy storage systems (ESS), there is a growing need for intelligent Home Energy Management Systems (HEMS). A well-designed HEMS must not only coordinate energy usage, generation, and storage but also address user comfort and economic objectives—particularly when homes are equipped to sell excess electricity back to the grid. However, the conflicting goals of minimizing energy cost, maximizing user convenience, and reducing Peak-to-Average Ratio (PAR) make this a complex multi-objective optimization problem. This project focuses on developing an optimal HEMS framework modeled as a Mixed-Integer Nonlinear Programming problem. The model will integrate key components: RES (e.g., solar PV), ESS, home appliances with varying operational priorities, and dynamic grid interactions (buy/sell). The system will optimize multiple conflicting objectives under real-world constraints and electricity pricing scenarios, including fixed, time-of-use, and dynamic feed-in tariffs. Simulations using real residential energy consumption and solar generation data will be conducted under various usage scenarios (normal, economic, and smart). The **project scope** includes: (1) Literature review of relevant recent works on HEMS; (2) Formulate a multi-objective MINLP model for home energy management integrating RES, ESS, and appliances. (3) Simulate different energy usage scenarios under varying electricity pricing and selling schemes. (4) Optimize for energy cost, user comfort, and Peak-to-Average Ratio (PAR). (5) Evaluate system performance and generate insights for smart home applications. Students are expected to develop the following skills (**learning outcome**): (16) Formulate and solve complex multi-objective MINLP problems in smart grid contexts. (17) Model and simulate home energy systems with RES, ESS, and grid interactions. (18) Analyze energy scenarios under dynamic pricing and selling schemes. (19) Evaluate energy systems for cost, efficiency, and user-centric performance metrics The deliverable outcomes by the FYP students are: (1) Optimized HEMS MINLP Model incorporating complete formulation with integrated RES, ESS, and grid buy/sell logic. (2) Simulation Framework and dataset simulations under various scenarios and pricing schemes. (3) Final Report, documenting the methodology, results, insights, and policy implications. **Prerequisite:** Background in energy systems, Proficiency in Python or MATLAB.
Student Workload Distribution	Student 1: formulating the MINLP model, developing the optimization framework, and implementing the simulation code.
	Student 2: data collection, scenario design, result analysis, and visualization, including evaluation under various pricing and usage conditions.
Supervisor	Dipti Srinivasan, dipti@nus.edu.sg
Laboratory Work	Computer
No. of students	2
CA1 requirements	Conduct literature review; gather/load residential energy data; formulate baseline MINLP model and define constraints and objectives.
CA2 requirements	Perform simulations for multiple pricing and usage scenarios; evaluate and compare results; finalize report, model code, and recommendations.

ID: SP13	This FYP proposal is for 3+1+1 students at NUSRI Suzhou
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Development of Mobile Gait Assessment system – Vision based approach
Summary (200 – 400 words)	Mobility and walking function is a key reflector of health status. This is true to the extent that walking speed has been designated the sixth vital sign, as it accurately reflects functional status and overall health for a wide population of patients. Tools and outcome measures for the accurate evaluation of mobility and walking ability are required to aid in accurate diagnosis and targeted rehabilitation interventions for mobility function. Surrogate measures such as measures of strength and endurance, do not accurately reflect walking ability. Gait evaluation is key to guide management and rehabilitation of mobility function. The **project scope** includes: (1) Literature review on gait modelling and assessment; (2) To develop vision-based algorithms and solution for gait assessment Students are expected to develop the following skills (**learning outcome**): (1) To understand basic knowledge of Telehealth and its key components; (2) To be skilled in computer vision; The achievable outcomes by the FYP students are: Development of a vision-based Gait algorithms. This project can take up to 2 students: Students 1 & 2: focus on the vision-based gait assessment. Each focuses on different vision algorithms. There are various gait parameters that we would like to extract and students can focus on different parameters. This project is suitable also for you to continue during your 1 year Master programme in NUS. **Prerequisite: Must be comfortable with programming**
Student Workload Distribution	Student 1: work together to setup software platform, student 1 will primarily focus on heal-strike angle and explore methods to validate the method.
	Student 2: work together to setup software platform, student 2 will primarily focus on toe-off angle, timing duration of different phases of TUG.
Supervisor	Arthur Tay, eletaya@nus.edu.sg
Laboratory Work	computer
No. of students	2
CA1 requirements	Literature review and software development. Develop algorithm.
CA2 requirements	Development of gait assessment system

ID: SP14	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Multiple Object Recognition using Machine/Deep Learning Models in Autonomous Vehicles – A Software and Hardware based performance evaluation study
Summary (200 – 400 words)	Object recognition technology is widely used in products such as smart phones, publicly deployed cams, etc. In this project, we attempt to recognize and getting correct position of several objects from the images accurately and quickly in real time. The images are received from a cam mounted on a self-driving vehicle. Accurate recognition facilitates preventing accidents and helps the vehicles to decide what to do next on the road. Project has two parts - (1) In the first part, the main objective of this project is about using at least two different kind machine learning models to detect multiple objects by providing the training data such as images that has been annotated by the human to train the models to be able to recognize and getting correct position of the object from the test data. Once methods are identified, we will attempt to implement and evaluate the performance of the methods and identify which method is suitable for real- time detection. We will attempt to use certain performance metrics to quantify the performance (rate of learning, quality of prediction, etc) of the methods. One of the grand challenges is in recognizing multiple objects within in a given image. (2) To implement on small scale embedded systems like, STM32 / Raspberry Pi, etc. This involves, interfacing a camera, receiving images, running a small scale ML model, and measuring the performance. Relevant references and reading material will be given. In addition, if time permits, we will attempt to recognize an object in poorly lighted conditions. The ***project scope*** includes: (1) Literature review of object recognition methods and use of Tensorflow/PyTorch and other Deep learning tools to implement the methods; (2) To evaluate the performance of the methods and perform a comparative study. (3) Use of small-scale embedded system like Raspberry Pi or STM32 MCs. Students are expected to develop the following skills ***(learning outcome***): To understand basic knowledge of object recognition process & methods To evaluate a given object recognition method and to use appropriate metrics The ***achievable outcomes*** by the FYP students for the CA assessment are: (1) To identify and implement object recognition methods (2) Performance Evaluation - certain influencing parameters; accuracy of prediction. (3) Implement on any chosen MC **Pre-requisites** – Python-Tensorflow/PyTorch/OpenCV/Machine learning packages; must be able to interpret and analyse data. If there are two students to work on the project, each student should carry out two different methods for a given dataset and perform all-to- all comparison. If time permits, multiple-objects under poorly lighted conditions will be attempted.
Student Workload Distribution	Student 1: A base model – joint effort, one individual learning model and hardware implementation, compare with Student 2;
	Student 2: A base model – joint effort, one individual learning model and hardware implementation, compare with Student 1;
Supervisor	A/Prof Bharadwaj Veeravalli, elebv@nus.edu.sg
Laboratory Work	Software/Laptop, Microcontroller (STM32 or Raspberry Pi,etc)
No. of students	2
CA1 requirements	Students must be familiarize themselves on the object recognition algorithms/methods; Relevant programming tools must be learnt and must demonstrate small scale relevant examples
CA2 requirements	To implement and evaluate the performance of multiple object recognition methods – demonstration of a full-fledged implementation with relevant dataset.

ID: SP15	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Photoplethysmography (PPG) sensors for heartbeat and SpO_2 monitoring
Summary (200 – 400 words)	Photoplethysmography (PPG) sensor is widely used for detecting volumetric changes in the blood in peripheral circulation. When light travels through biological tissues, it is absorbed by skin pigments, bones and the circulating blood. The change in blood flow can be detected by measuring either the reflectance or absorbance of the light using a photodetector. The resultant voltage signal from the photodetector corresponds to cardiac synchronous changes in the blood volume with each heartbeat. Using two light emitting diodes (LEDs) of different wavelength, e.g., one is in infrared and the other is in the red region, it is possible to measure the oxygen saturation (SpO_2) level, which is crucial for a human body to function properly. Due to its non-invasive nature and low cost, the PPG is widely used in clinical physiological measurement and monitoring. In this project, a two-student team will develop a prototype PPG sensor using discrete components, test and benchmark its performance with commercial products and develop algorithms to calculate heartrate, heart rate variability, and oxygen saturation (SpO_2) from the acquired PPG signals. The **project scope** includes: 1) Do a literature review on PPG sensor and prepare a block diagram for the overall detection circuitry. 2) List out all the components that are required to build the circuit (ensure that it is within the allocated budget), source for and purchase all the components, build and test the sensing circuit. 3) Collect PPG signal and compare it with those obtained from commercial sensors. 4) Develop algorithm to calculate heartrate and SpO_2 from the measured data and compared the results with those obtained from commercial devices. Students are expected to develop the following skills (**learning outcome**): 1) To learn how optoelectronic devices such as light emitting diode and photodetectors are used in clinical and healthcare monitoring. 2) To learn how to build electronic circuits that are directly related to real world applications. 3) To learn basic techniques for data acquisition and processing. 4) To learn how to deal with noise which is always present in real systems The deliverable outcomes by the FYP students are: 1) A functional, self-built PPG sensor using discrete components. 2) Software to extract heart rate, heart rate variability, and SpO_2 from PPG signals. 3) Benchmarking results comparing the prototype with commercial devices. 4) Final report documenting design, results, and a live or recorded demonstration of the system.; **Prerequisite:** Prior experience of hardware and software implementation is a must.
Student Workload Distribution	Student 1: Build the PPG sensor hardware, set up the circuit for signal acquisition, test the hardware, and help compare it with commercial devices (details to be worked out).
	Student 2: Write the code to extract heart rate, HRV, and SpO_2, analyze and visualize the data, check accuracy, and help with the final report and presentation.
Supervisor	Wu Yihong; email: elewuyh@nus.edu.sg
Laboratory Work	Bench-top instruments, electronic components, LED, PD, computer
No. of students	2
CA1 requirements	Prototype circuit is ready for detecting blood flow; Basic algorithms for heartrate, heart rate variability, and SpO_2 calculations are ready.
CA2 requirements	System level demonstration of the PPG; Demonstration of algorithms for accurate heartrate, heart rate variability, and saturation oxygen monitoring.

ID: SP16	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	A Legged Robot with Unconventional Locomotion and Payload Handling Across Varied Terrain
Summary (200 – 400 words)	Legged robots have proven useful in navigating environments that challenge traditional wheeled designs. This project proposes the development of "Weird Walker," a compact robot that leverages an unconventional walking mechanism to traverse varied terrains while carrying sensitive payloads such as a cup of water. This robot will demonstrate advanced balance and adaptability to complex real-world surfaces. This project is to design a legged robot with unique and effective walking mechanisms to achieve adaptive locomotion across flat, uneven, and inclined terrains. This project will also implement a stabilized payload system capable of preventing spillage of liquid cargo through innovative mechanical design configurations. The design can consider using unconventional gait systems with bio-inspired mechanics. Adaptive gait control using IMU and terrain sensors. The payloads balancing can be implemented by gimbal or passive damped stabilization. the design should be modular for easy reconfiguration and testing. This project presents both a technical challenge and an opportunity to innovate within mobile robotics. The **project scope** includes: (1) Literature review on legged locomotion and stabilization; (2) Simulate walking patterns and, implement leg mechanisms and servo integration ; (3) Integrate sensor systems (IMU and terrain sensors) for adaptive control; (4) Develop and integrate a payload stabilization platform; (5) Analyze performance, refine mechanics and software. Students are expected to develop the following skills (**learning outcome**): (20) To get familiar with design and prototype a legged robotic platform using CAD tools and 3D printing; (21) To understand structural requirements for locomotion and payload support; (22) To apply real-time control techniques for gait regulation with embedded system; (23) To develop feedback control loops for improved stability and performance. The deliverable outcomes by the FYP students are: (1) To simulation and mechanical prototype the robot. (2) To design and integration of stabilization platform. (3) To autonomous navigation with camera. (4) To integrate the system and test across varied terrain and refinement. **Prerequisite:** Prior experience of software and hardware implementation is a must.
Student Workload Distribution	Student 1: Design and test the robot with spider-like legs. Student 2: Design and test the robot with composite-type legs.
Supervisor	Zhang Jianwen, elezhan@nus.edu.sg
Laboratory Work	Bench-top instruments, computer, 3D printer.
No. of students	2
CA1 requirements	Simulation of the gait of legged robot. Prototype with hardware and software development and demonstration.
CA2 requirements	Integrate the robot with complete hardware and software systems. A full working demonstration over various terrain and payload.

ID: SP17	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	End-to-End Navigation Policy Learning for Ground Robots Using Stereo Vision
Summary (200 – 400 words)	Vision-based navigation is increasingly important for ground robots operating in complex, dynamic environments. While traditional navigation stacks decompose the problem into perception, mapping, and planning modules, new advances in deep learning enable end-to-end policies that map sensor inputs directly to robot actions, and powerful world models that provide spatial understanding from raw data. This project explores a hybrid approach: developing and integrating a transformer-based navigation world model with a modular end-to-end navigation policy, both using only stereo vision input. The project's objective is to enable ground robots to interpret stereo imagery, build spatial awareness, and generate robust navigation commands through modern deep learning methods. Students will use simulation environments (e.g., Isaac Sim or Habitat) to replicate a stereo camera setup and generate diverse, realistic navigation scenarios for data collection and model training. Both components, the transformer-based navigation world model and a modular end-to-end navigation neural framework, will be developed, trained, and evaluated separately—first in simulation, then on a real ground robot platform. The project scope includes: (1) Literature review on deep learning for robot navigation, transformer world models, and modular end-to-end policies. (2) Simulation and dataset generation for stereo vision-based navigation. (3) Design and training of (a) a transformer-based navigation world model (Student 1), and (b) a modular end-to-end navigation policy (Student 2). (4) Integration and evaluation in both simulated and real-world environments. Students are expected to develop the following skills (learning outcome): (1) Gain hands-on experience with advanced neural network architectures for robotics, including transformers and modular design. (2) Learn to process stereo vision for world modeling and control. (3) Develop practical skills for simulation-to-real transfer in robot navigation. (4) Become proficient in Python, ROS, and simulation tools (Isaac Lab, or Habitat). The deliverable outcomes by the FYP students are: (1) Simulated stereo camera setup and data generation pipeline. (2) Implementation of a transformer-based navigation world model. (3) Implementation of a modular end-to-end navigation policy. (4) Integrated system for end-to-end navigation using stereo vision. (5) Demonstration and benchmarking on a real ground robot. **Prerequisite:** Strong Python skills, foundational knowledge of deep learning (PyTorch or TensorFlow), and experience with 3D vision (OpenCV, ROS). Familiarity with simulation tools (Isaac Sim or Habitat) is advantageous.
Student Workload Distribution	Student 1: Design, training, and evaluation of the transformer-based navigation world model. Set up the simulation environments.
	Student 2: Design, training, and evaluation of the modular end-to-end navigation model. Set up the real robot test.
Supervisor	ZHAO Lin, zhaolin@nus.edu.sg
Laboratory Work	Computer with GPU RTX 4080 or better is required.
No. of students	2
CA1 requirements	Literature review, simulation and data pipeline setup, initial network designs.
CA2 requirements	Comprehensive demonstration and benchmarking of the two navigation models on a real robot.

ID: SP18	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	State-of-Charge and State-of-Health Monitoring of Batteries
Summary (200 – 400 words)	Monitoring the state-of-charge (SoC) and state-of-health (SoH) of batteries is essential for modern energy systems. Accurate SoC/SoH estimates ensure precise control, enhance safety, and extend battery lifespan, making them crucial for electric vehicles, consumer electronics, and renewable storage. This project aims to develop a high-precision, AI-enhanced method for real-time SoC and SoH monitoring using deep learning. Students will work with an experimental dataset obtained from a non-invasive monitoring approach, applying advanced data analysis and machine learning to accurately estimate battery condition. By comparing different AI models, the project highlights how intelligent monitoring can transform the way we manage battery systems. The **project scope** includes: (1) Conduct a literature review on existing battery SoC and SoH monitoring methods; (2) Develop two different deep learning models for SoC and SoH estimation; (3) Validate model performance using experimental datasets; (4) Compare the developed approaches, analyzing strengths and trade-offs. Students are expected to develop the following skills (**learning outcome**): (24) Understand the challenges and significance of battery health monitoring; (25) Learn to evaluate and develop AI-based solutions for battery monitoring; (26) Gain experience with deep learning frameworks and performance validation; (27) Develop critical analysis skills to compare different approaches. The deliverable outcomes by the FYP students are: (1) Literature review summarizing existing SoC/SoH monitoring techniques; (2) Two AI-based monitoring models (one by each student), implemented and trained on the provided dataset. (3) Validation results, performance metrics, and a comparative study. **Prerequisite:** (1) Basic understanding of battery operation and monitoring; (2) Familiarity with AI and machine learning, especially classification tasks; (3) Interest in energy systems and data-driven technologies.
Student Workload Distribution	Student 1: Literature review, development of one deep learning method, comparative analysis.
	Student 2: Parallel literature review, development of another deep learning approach, comparative analysis.
Supervisor	Zhao Zhenyu, zhaozy@nus.edu.sg
Laboratory Work	Computer-based data processing, coding, and model implementation.
No. of students	2
CA1 requirements	Literature review, problem analysis, initial deep learning design, and early implementation.
CA2 requirements	Completed AI models with validation, final report, and presentation.

ID: SP19	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Screen-printed Biosensor for Sweat Biomarker Detection
Summary (200 – 400 words)	Diabetes management requires frequent glucose monitoring. Existing methods are invasive and inconvenient, driving the need for non-invasive solutions. Sweat, containing various biomarkers including glucose, offers a promising alternative. The development of such a non-invasive, continuous monitoring system holds significant promise for improving patient quality of life and enhancing diabetes management. Among various sensing technologies, electrochemical biosensors stand out as promising sensing devices as they provide sensitive, rapid, and cost-effective detection. This project aims to develop screen-printed biosensors for glucose detection from sweat. Screen printing, enabling scalable, wearable sensor fabrication, will be developed to fabricate the biosensors. Next, these sensors will be integrated with portable Arduino tools and smartphone communication capability, which facilitate real-time and remote monitoring, creating an accessible system for non-invasive glucose and biomarker detection in sweat. The **project scope** includes: (1) Literature review of biosensors, screening printing, portable measurement systems and relevant technologies; (2) Design, fabrication and characterization of biosensors made with screen-printing; (3) Design, setup and testing of portable measurement system based on Arduino; (4) Integration of biosensors and portable measurement system for glucose detection. Students are expected to develop the following skills (**learning outcome**): (28) To understand working principles of electronic device and biosensors; (29) To be skilled on thin film process, especially on screen-printing technologies and device characterization; (30) To be skilled on embedded system development with wireless communication and basic mobile application development; (31) To be skilled on integration of sensing technologies and portable measurement system. The deliverable outcomes by the FYP students are: (1) To design and fabricate functional screen-printed biosensors; (2) To build and test portable Arduino-based measurement system; (3) To measure glucose using the biosensor and portable measurement system; (4) To improve the device and system design based on the testing. **Prerequisite**: Prior experience of software and hardware implementation is a must.
Student Workload Distribution	Student 1: on device/biosensor, design, fabrication and characterization of biosensors using scree-printing technologies and for glucose detection.
	Student 2: on portable Arduino-based measurement system with communication between device and smartphone, data collection and analysis, and integration with biosensors.
Supervisor	Zhu Chunxiang, Email: elezhucx@nus.edu.sg
Laboratory Work	Bench-top instruments, computer, impedance analyzer
No. of students	2
CA1 requirements	Design and fabrication of screen-printing technologies for biosensors. Design and setup of portable measurement system. Simple demonstration.
CA2 requirements	Integration of biosensors and portable measurement system for glucose biomarker detection.

ID: SP20	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Project Title	Graph-Based Machine Learning for Automated Feedback on Student FSM Designs in Verilog/VHDL
Summary (200 – 400 words)	Finite State Machines (FSMs) are foundational in digital design education, commonly implemented through Verilog or VHDL assignments. However, assessing FSM designs is labor-intensive, especially when providing rich, formative feedback. Existing automated grading approaches rely mainly on testbench outputs or code similarity, which offer limited insight into the structural quality of a student's design. This project aims to develop a graph-based machine learning (ML) framework that analyzes FSM implementations and generates targeted feedback for students. By parsing Verilog/VHDL code into graph representations—where nodes represent states and edges represent transitions—this framework can extract meaningful structural features (such as unreachable states, redundant transitions, and state complexity). Machine learning models will then be trained to classify and evaluate design quality, using a large dataset of previously submitted student FSM assignments and projects. The **project scope** includes: (1) Literature review on FSM graph extraction techniques and educational applications; (2) Developing code parser to convert HDL FSMs into graph structures enriched with metadata (3) Training ML models using graph-based features to detect design flaws or assess quality software modules. (4) Developing feedback engine that visualizes FSM graphs. Students are expected to develop the following skills (**learning outcome**): (1) To understand FSM principles and HDL implementation styles; (2) To be familiar with graph processing and ML techniques; (3) To be familiar integrating graph processing and machine learning deployment; The deliverable outcomes by the FYP students are: (1) A graph-based parser and ML model trained on real student FSM data. (2) Prototype feedback system with visualizations and recommendations. (3) User testing of prototype feedback system. **Prerequisite:** Comfortable with learning Verilog/VHDL, Python programming, and basic machine learning concepts.
Student Workload Distribution	Student 1: Verilog Code parsing, FSM graph extraction, feature engineering. Student 2: Machine learning model design, feedback engine development, visualization, and evaluation.
Supervisor	Chua Dingjuan, elechuad@nus.edu.sg
Laboratory Work	Software (Requires access to HDL development tools such as Vivado)
No. of students	2
CA1 requirements	Working FSM parser with graph visualization and initial feature extraction pipeline.
CA2 requirements	Integrated ML-driven feedback system with prototype deployment for user testing.

ID: SP21	This FYP proposal is for 3+1+1 students at NUSRI Suzhou
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Development of space object relative trajectory model for active collision avoidance
Summary (200 – 400 words)	The increasing number of satellites launched into Low Earth Orbit (LEO) significantly raises the risk of orbital collisions. The Satellite Technology and Research (STAR) Centre successfully launched the 18 kg satellite Lumelite-4 in April 2023. However, the satellite has been receiving at least six collision warnings per month. To address this growing risk, the STAR Centre is currently developing an onboard active space object detection system. The onboard system allows the satellite to detect any space object, predicts the space object's relative trajectory, and evaluate the risk of collision. If the risk of collision is high, the satellite executes the collision avoidance maneuver via onboard propulsion system. This project aims to develop the relative trajectory model of the space object observed by satellite. The developed relative trajectory model will be used to determine the minimal distance between space object and satellite, and time of the minimal distance occurs (if exists). A mixed of high-order polynomial, high-order trigonometry and exponential function will be considered in this project to capture the complex dynamics and periodic behaviour of relative trajectory model. Students are expected to review and select appropriate optimization algorithm such as particle swarm optimization, grey wolf optimization, ant colony optimization and etc for implementation purpose. The modelling results will be tested and evaluated via the real satellite orbit data with respective conjunction assessment data, provided by the STAR Centre. **The project scope includes:** (1) Literature review of satellite's orbital mechanics; (2) Literature review of optimization algorithms; (3) Literature review on constraint based optimization; (4) Literature review of power series representation, and (5) Select and implement optimization algorithms for relative trajectory modelling. Students are expected to develop the following skills (**learning outcome**): (1) To understand the orbital mechanics; (2) To be familiar with the different optimization algorithms; (3) To be skilled at developed constraint conditions for modelling purpose, and (4) To be skilled at python programming. The deliverable outcomes by the FYP students are: (1) To implement up to two optimization algorithms for relative trajectory modelling; (2) To test and validate the performance of implemented algorithms, and **Prerequisite:** Python or knowledge is essential.
Student Workload Distribution	Student 1: on development and implementation of one optimization algorithm. Student 2: on development and implementation of another optimization algorithm.
Supervisor	GOH Shu Ting, shuting@nus.edu.sg
Laboratory Work	Computer
No. of students	2
CA1 requirements	Determine the relative trajectory model to be used. Presentation of the preliminary results from optimization algorithm.
CA2 requirements	Presentation of the performance analysis of each optimization algorithm on relative trajectory modelling method.

ID: SP22	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Simulation and Understanding of Power Devices Using Wide Bandgap Materials for Electrical Vehicles
Summary (200 – 400 words)	Power devices are becoming more and more important and have widespread applications, such as electrical vehicles. Wide bandgap materials have superior material properties than Si in terms of figure-of-merit for power applications. Depending on different applications, power devices would employ different device structures. Also, in these devices, different defects would affect the electrical characteristics significantly. This project aims to simulate, understand, and analyze the electrical characteristics of power devices with different difference device structures, including the effect of different types of defects. The project scope includes: (1) To understand the physics of power devices in literature review (2) To design and simulate some basic electrical characteristics of power devices using TCAD (3) To analyse the current-voltage performance of the power devices fabricated, including the drive current, breakdown voltage, etc (4) To understand the effect of various defects on the electrical performance of the transistors and guide future experiments to achieve better device performance Through this project, students are expected to develop the following skills (learning outcome): (1) To understand basic knowledge and device physics of power devices (2) To be skilled at Matlab programming. (3) To be skilled at TCAD simulation such as Sentaurus (4) To be able to extract various key device parameters and provide guidance for further experiment to improve the device performance. The deliverable outcomes by the FYP students are: (1) To simulate both planar MOSFETs and trench MOSFETs (2) To obtain the I-V and C-V electrical characteristics with various device structures and dimensions (3) To extract various key device parameters that are strongly correlated to the electrical performance of the transistors, and guide future experiments to achieve better device performance. (4) To write good technical reports and possibly submit papers to international conferences or journals.
Student Workload Distribution	Student 1: Simulation and analysis of planar MOSFETs
	Student 2: Simulation and analysis of trench MOSFETs
Supervisor	Gong Xiao; elegong@nus.edu.sg
Laboratory Work	Matlab, TCAD such as Sentaurus
No. of students	2
CA1 requirements	Literature review and simulation of the basic electrical characteristics of power devices using TCAD
CA2 requirements	Simulation and analysis of the electrical characteristics of advanced device structures using TCAD

ID: SP23	This FYP proposal is for 3+1+1 students at NUSRI Suzhou
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Distributed amplifier for wideband application
Summary (200 – 400 words)	Distributed amplifier is widely used for wideband application. The key idea is to combine the output of multiple compact amplifier output through a combination of input transmission line and output transmission line. This results in smaller amplifier parasitic and enables the absorption of the parasitic within the transmission line, achieving wider bandwidth than single amplifier. In this project, we will explore distributed amplifier design targeting at 100GHz bandwidth. In particular, we will look at two different applications. In the first application, the distributed amplifier is employed for identical input signal to achieve wideband amplified output. In the second application, the distributed amplifier is employed for two different signal time shifted by half clock delay, and achieving edge combining effect at the output to attain even higher data rate. The **project scope** includes: (1) Literature review of distributed amplifier architecture; (2) Design and simulate the distributed amplifier (at least two stages); (3) Evaluate the performance and benchmarked with other distributed amplifier design; Students are expected to develop the following skills (**learning outcome**): (5) To understand the distributed amplifier architecture; (6) To develop EDA tool usage skillset; (7) To develop schematic design and circuit simulation skill; (8) To be able to evaluate distributed amplifier performance; The achievable outcomes by the FYP students are: (1) A completed distributed amplifier design with transistor level schematic; (2) A complete simulation results to evaluate the distributed amplifier performance. **Prior experience of software and hardware implementation is a must.** If there are two students to work on the project, each student should carry out different design, and achieve the above-mentioned outcomes. **Prerequisite:** Prior experience of EDA, such as cadence, is a must.
Student Workload Distribution	Student 1: Work on the distributed amplifier for identical input
	Student 2: Work on the distributed amplifier for different input to achieve edge combining effect
Supervisor	Heng Chun Huat, elehch@nus.edu.sg
Laboratory Work	Not applicable
No. of students	2
CA1 requirements	Review of distributed amplifier architecture and transmission line design
CA2 requirements	Implementing the distributed amplifier

ID: SP24	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Non-Hermitian topological ring sensor
Summary (200 – 400 words)	In this project, students will analyze and design a non-Hermitian topolectrical (TE) ring circuit with non-reciprocal coupling. The objective is to model and design a sensor circuit which is sensitive to changes to the terminal coupling capacitance. The sensing circuit will be designed with the optimal circuit component values to achieve the highest sensitivity and stability. The circuit design will be carried out using the LTspice library which incorporates realistic parasitic components as well as tolerance range of normally available circuit components. The circuit output will be characterized as a function of various parameters, e.g. terminal coupling and system length. It would also involve the design of impedance converter with current inversion (INIC) which is required for non-reciprocity. The project scope includes: viii) Literature review of research articles covering basic TE circuits ix) Study of basic Hermitian TE circuits such as the SSH circuit x) Study of basic non-Hermitian TE circuits such as the Hatano-Nelson circuit xi) Design and simulate INICs for non-reciprocity and non-Hermitian behaviour xii) Study the non-Hermitian ring sensor circuit. xiii) Modelling of the TE ring circuits with circuit simulation software e.g. LTspice. xiv) Study and optimizing the output of the TE ring sensor circuits xv) Characterizing the sensitivity of the sensing circuit as a function of various circuit parameters Students are expected to develop the following skills (learning outcome): vi) Realistic circuit simulations using simulation packages such as LTspice vii) Analytical and numerical programming skills with Mathematica or Matlab viii) Able to design and implement INIC which is required for non-Hermiticity and gainy/lossy behaviour. ix) Able to design and analyze ring-based TE sensor circuits x) Able to design the PCB of ring-based TE circuits for sensing application The deliverable outcome by the FYP students for the CA assessment are: iii) General design and characterization of ring-based TE sensor circuits iv) Actual PCB design and implementation of ring-based TE sensor circuits If there are two students to work on the project, each student should take charge of different aspects of the circuit design, PCB design and circuit implementation.
Student Workload Distribution	Student 1: On theory and circuit design, circuit characterization of sensor circuit and INICs
	Student 2: On circuit simulation, PCB design, circuit implementation of sensor circuit and INICs
Supervisor	Mansoor Bin Abdul Jalil
Laboratory Work	Matlab, Mathematica and LTspice software, PCB design and circuit characterization
No. of students	2 (not more than 2 students for each project)
CA1 requirements	General theory and implementation of basic TE circuits
CA2 requirements	To achieve the goals set out in Deliverables (i) and (ii).

ID: SP25	This FYP proposal is for 3+1+1 students at NUSRI Suzhou
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Embodied AI for Autonomous Surgical Task Execution in Medical Centre
Summary (200 – 400 words)	With the aim of advancing autonomy in surgical robotics, we propose to develop an Embodied AI system that can interpret natural task instructions, perceive the surgical scene in real time, and execute tasks autonomously in a simulated surgical environment. By integrating vision, language, and action in a closed-loop framework, the system can adapt to changes during execution, overcoming the limitations of traditional pre-scripted simulators. This project will design an embodied AI system combining software modules and simulator integration to enable safe, adaptive control for representative surgical tasks. Unlike static policy execution, the system will continuously perceive and respond to environmental feedback, enabling more robust and reliable autonomous performance. The project scope includes: (1) Literature review of embodied AI, vision-language-action models, and their application in surgical robotics; (2) Perception module development to process RGB-D video and tool pose data from a surgical simulator; (3) Policy generation module using a vision-language model to translate high-level instructions into executable robot actions; (4) Integration of reinforcement learning for policy improvement through simulated trials; (5) System integration and demonstration of closed-loop autonomous task execution. Students are expected to develop the following skills (learning outcomes): (1) To understand embodied AI concepts and their implementation in robotics; (2) To be familiar with vision-language model adaptation and multimodal perception; (3) To be skilled at simulator integration and reinforcement learning; (4) To be skilled at building closed-loop robotic control systems. The deliverable outcomes by the FYP students are: (1) To construct a working embodied AI pipeline capable of executing surgical tasks in simulation; (2) To demonstrate real-time perception-to-action control using the simulator; (3) To implement reinforcement learning for policy refinement; (4) To evaluate and document system performance across multiple tasks. **Prerequisite:** Experience in Python programming, computer vision, and deep learning; familiarity with PyTorch and 3D modelling is preferred.
Student Workload Distribution	Student 1: on perception and representation learning, including integrating RGB-D video and tool pose data from the simulator, implementing the perception module for real-time scene understanding, and building the simulator–VLM interface for task execution.
	Student 2: on closed-loop policy generation and system integration, including training and fine-tuning the vision-language-action model, implementing reinforcement learning for policy improvement, and evaluating system performance across multiple surgical tasks.
Supervisor	Yueming Jin, ymjin@nus.edu.sg
Laboratory Work	Computer
No. of students	2
CA1 requirements	Initial prototype of the perception-to-policy pipeline with basic simulator integration. Simple demo of a surgical task executed from a static instruction.
CA2 requirements	Fully integrated embodied AI system with real-time perception, closed-loop control, and RL optimization. Full demo of adaptive task execution in a surgical simulator, including performance metrics.

ID: SP26	This FYP proposal is for 3+1+1 students at NUSRI Suzhou
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Development of a Multimodal Tactile Robotic Hand for Adaptive Object Manipulation
Summary (200 – 400 words)	With the intention to enhance robotic manipulation capabilities through tactile sensing, we aim to develop a multimodal tactile robotic hand system, capable of performing basic adaptive grasping and manipulation tasks. This project seeks to integrate tactile sensing technology, robotic hardware, and intelligent control software to create a biomimetic robotic hand. Compared with traditional robotic grippers, this system provides improved dexterity and adaptive grasping through real-time tactile feedback and multimodal sensory inputs. The project scope includes: (1) Literature review on robotic tactile sensing technologies, biomimetic mechanical design, and adaptive control algorithms; (2) Hardware development involving flexible tactile sensors integration, cable-driven robotic fingers design, and microprocessor-based data acquisition; (3) Software development including sensor data processing, adaptive grasp algorithms, and basic control interface design; (4) Integration of hardware and software into a fully functional robotic hand system capable of real-time adaptive manipulation. Students are expected to develop the following skills (learning outcomes): (1) Understanding of tactile sensor technologies and robotic hand design principles; (2) Familiarity with hardware design and system-level integration; (3) Proficiency in microprocessor programming and sensor data analysis; (4) Capability to implement basic adaptive control algorithms. The deliverable outcomes by the FYP students are: (1) A functional multimodal tactile robotic hand prototype meeting specified requirements; (2) Implementation of tactile sensing technology enabling adaptive grasp capabilities; (3) Software capable of processing tactile feedback for real-time manipulation; (4) Validation and improvement of the system performance based on practical user testing and feedback. Prerequisite: Prior experience in hardware design, microprocessor programming, and software integration is required.
Student Workload Distribution	Student 1: on hardware construction including the robotic hands, sensors, microcontroller, mechanical construction.
	Student 2: on communication between device and computer, data collection and analysis, game design and interface with the medical database.
Supervisor	Chengkuo Lee, elelc@nus.edu.sg
Laboratory Work	Bench-top instruments, computer, 3D printer.
No. of students	2
CA1 requirements	Preliminary prototype with hardware and software development. Simple demonstration.
CA2 requirements	Interactive Upper Limb Training Device with complete hardware and software systems, including complete data analysis and full working demonstration

ID: SP27	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Radar Sensor System for the Detection of Human Motion behind Wall
Summary (200 – 400 words)	In this project, we will build a low-cost radar sensor system to detect human motion behind wall, such as number of human and their physical gesture. This is particularly useful for rescue operation after the natural disasters. Reference web information for low-power radar system: https://www.youtube.com/watch?v=gU-Rrwf1vr0&ab_channel=AndreasSpiess Students are to complete the hardware circuits and to implement the software to display the outcome on the computer screen, or any display. The detection should be made through (a) air, (b) glass, (c) wooden wall, (d) concrete wall, (e) metal sheet, etc. For human facing directly with the radar sensor, i.e. not behind the wall, the image should be very clear and the software should also analyse the human arm gesture to issue control command for the appliance, such as to turn on and off the light by waving the arms. Other applications, such as measuring the physical distance between two humans can also be implemented, and to count the number of humans in a group. In summary, the FYP outcomes to be implemented are: (a) Detect the human position and gesture behind the wall (b) Use human gesture to control appliance such as turn on and off the lights (c) Measuring distance between two humans (d) Counting the number of humans in a group (e) Detect the human's health data, such as heart beat and breath rate. This is particularly important to know if the person is still alive.
Student Workload Distribution	Student 1: Work on the hardware including all electronic circuits
	Student 2: Work on the software to enhance the detection precision
Supervisor	YC Liang (chii@nus.edu.sg)
Laboratory Work	Bench-top instruments, computer, software, microcontroller
No. of students	2
CA1 requirements	Basic radar sensor function for (a) and (c)
CA2 requirements	Full performance for (a) – (e)

ID: SP28	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Title of Project	Low-cost and lightweight corner reflectors for SAR calibration and verification
Summary (200 – 400 words)	The objective of the project is to develop and test low-cost and lightweight corner reflectors for SAR calibration and verification. Synthetic aperture radar (SAR) on satellites is used make SAR (radar) images of parts of Earth. An example of such a SAR satellite is Sentinel I, with its SAR images made publicly available by the European space agency (ESA). So-called corner reflectors (CR) are used to test the quality of the SAR images and several permanent corner reflectors are placed around the world for that purpose. A typical CR for Sentinel I can be about 2-3 meters at its base. A drawback of corner reflectors is that they are heavy and costly due to the metal parts used in the construction of the corner reflectors. This makes it cumbersome to transport corner reflectors in case of measurement campaigns. The objective of this project is to develop and test low-cost and lightweight CR that can be easily folded and transported. This may require the use of lightweight materials to be coated with thin metallic layers. The **project scope** includes: (1) Literature review on SAR imagining and ESA's sentinel I; (2) Develop an understanding of the principal operation of CR; (3) Development of concepts for lightweight and low-cost CRs; (4) Construction of CRs; (5) Measurement of CR response using Sentinel I data. Students are expected to develop the following skills (**learning outcome**): (32) To understand radar scattering mechanisms; (33) To understand synthetic aperture radar (SAR) imaging; (34) To understand the principal operation of CRs; (35) To develop novel concepts for low-cost and lightweight CR;; (36) To fabricate and test CRs. The achievable outcomes by the FYP students are: (1) Development of several concepts of lightweight and low-cost CRs; (2) Fabricated and tested lightweight and low-cost CR; (3) Possibly a conference contribution. . This project requires two students who are keen to work together on the development of innovative and low-cost corner reflectors.
Student Workload Distribution	Student 1: design, fabrication, and testing of the corner reflector structure
	Student 2: electromagnetic simulation of the designed corner reflector, Sentinel I image analysis
Supervisor	Koen Mouthaan k.mouthaan@nus.edu.sg
Laboratory Work	Bench-top instruments, HFSS simulations, experiments with Sentinel I imaging
N0. of students	2
CA1 requirement	Literature review, familiarization with SAR images, and corner reflectors;
CA2 requirement	Selection of CR concept, fabrication, and testing using Sentinel I

ID: SP29	This FYP proposal is for 3+1+1 students at NUSRI Suzhou
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Title of Project	Dynamics of Interconnected Renewables in Power Systems
Summary (200 – 400 words)	Renewable energy sources such as solar and wind are increasingly integrated into power systems via power electronic interfaces, collectively known as inverter-based resources (IBRs). The majority of IBR controllers currently operate in grid-following (GFW) mode, relying on the premise that system voltage and frequency are maintained by traditional, inertia-rich sources. However, these control strategies cannot ensure system stability in low-inertia environments and are unlikely to support future power systems dominated by inverters. To address potential instability, it is essential for renewable resources to provide regulation services by transitioning IBR control from GFW to grid-forming (GFM) mode. Grid-forming operation enables inverters to actively regulate voltage and frequency, thereby enhancing system resilience. A critical challenge remains: determining which IBRs, and how many, should switch to GFM mode under varying grid topologies to maintain stability and reliable operation. This proposal aims to systematically address this question, laying the groundwork for robust, inverter-dominated power systems. The project scope includes: (1) Literature review of inverters, and controller designs; (2) Detailed and reduced-order modelling of IBRs; (3) Develop detailed models of power systems with varying levels of inertia and renewable penetration; (4) Develop practical guidelines for grid operators on deploying GFM capabilities. Students are expected to develop the following skills (learning outcome): (37) To be familiar with fundamental power engineering principles; (38) To be familiar with linear control theory; (39) To be able to model inverters and construct power system models; (40) To be able to assess grid stability using eigenvalue analysis; (41) To become competent in MATLAB/Python. Expected deliverables by the students are: (1) Conduct a detailed literature review on the modelling and control of inverters and electric loads in power systems; (2) Actionable guidelines for system operators on when and how to deploy GFM control; (3) Assess the optimal number of IBRs required and their locations to maintain grid stability.
Supervisor	Jimmy PENG
Laboratory work	MATLAB/Python
No. of students	2
CA1 requirement	Showcase working grid-following and grid-forming inverters working in a grid model.
CA2 requirement	Develop a framework/guideline to determine the grid stability under different control architectures.

ID: SP30	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	High-bandwidth Noise-free Controller for SiC Dual Active Bridge DC/DC Converter
Summary (200 – 400 words)	Wide band gap (WBG) semiconductor devices are the future of high-density high-efficiency low cost and light wright power electronics. To unlock their potential, they are operated at very high switching frequency and their parasitic introduces noise. This project aims to analyse, develop, and implement a two-loop average current controller for closed loop control of a SiC voltage-fed DAB dc/dc converter to results in noise free operation and fast response for voltage gain applications. The project includes mathematical analysis, implementation of modulation strategy, design of components, simulation, and hardware development and testing. The **project scope** includes: (1) Steady-state operation study of voltage-fed DAB circuit topology with phase-shift modulation technique (2) Small signal analysis (SSM) of the SiC voltage-fed DAB dc/dc converter (3) Two-loop average current control system design with 2 PI controllers and perform stability analysis (4) Simulation of the closed loop control with input voltage and load current variation with SiC parasitic at high device switching frequency operation (5) Hardware development and testing and demonstrate control system performance Students are expected to develop the following skills (**learning outcome**): (1) To understand wide band gap semiconductor characteristics (2) To be familiar with two loop average current control, bode plots, stability analysis (3) To be skilled at small signal analysis and stability analysis (4) To be skilled at controller programming, control system hardware design and interface with power circuit hardware, and testing The deliverable outcomes by the FYP students are: (1) To demonstrate learning of small signal analysis and closed loop control system (2) To improve and demonstrate the noise-free operation (3) To enhance the response and reduce transients' time/duration **Prerequisite:** Prior knowledge of control is required.
Student Workload Distribution	Student 1: on small signal analysis, closed loop control design, and simulation
	Student 2: on control implementation through programming, modulation technique development, control hardware development Testing, calculation, and benchmarking will be done together
Supervisor	Akshay Kumar Rathore, akshay.rathore@nus.edu.sg
Laboratory Work	Bench-top instruments, computer, power supplies, logic power supply, meters and scope
No. of students	2
CA1 requirements	SSM mathematical analysis, PI controller design, simulation results
CA2 requirements	Preliminary prototype with hardware and control programming development. Simple demonstration.

ID: SP31	**This FYP proposal is for 3+1+1 students at NUSRI Chongqing**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Deep Learning Model for Accurate PUE Prediction in Data Centers
Summary (200 – 400 words)	Data centers are among the largest energy consumers in the digital economy, and improving their energy efficiency is a global priority. A key metric used to evaluate data center energy efficiency is Power Usage Effectiveness (PUE), which represents the ratio of total facility energy to IT equipment energy. Accurate prediction of PUE is essential for proactive operational optimization and sustainability. However, traditional prediction methods fall short in handling the highly non-linear and time-dependent relationships present in real-world data center operations, including variations in IT load, temperature, humidity, and cooling strategies. This project aims to develop a deep learning-based model to forecast PUE with high accuracy by capturing temporal dynamics and complex feature interactions. Leveraging recurrent architectures such as Long Short-Term Memory (LSTM) networks, the model will be trained on historical data generated from simulation tools or real-world datasets, encompassing key operational parameters. The pipeline will include data preprocessing, feature engineering, model design, hyperparameter tuning, and performance evaluation using metrics such as RMSE and MAE. The proposed model's performance will be benchmarked against conventional forecasting methods. The final deliverable will be a validated deep learning model for PUE prediction, along with reproducible code and evaluation results. This work has significant implications for energy-efficient data center management and environmental sustainability. The project scope includes: (1) Literature review of recent works; (2) Collect and preprocess historical data; (3) Design and implement an LSTM-based model for PUE prediction; (4) Train, tune, and evaluate the model using RMSE and MAE metrics; (5) Deliver a validated model with insights for energy-efficient operations Students are expected to develop the following skills (learning outcome): (42) Apply deep learning techniques (LSTM, GRU) for time-series prediction. (43) Perform preprocessing and feature engineering on high-dimensional temporal data. (44) Evaluate predictive models using error metrics (e.g., MAE, RMSE) and validation strategies. (45) Translate model outputs into actionable insights for energy optimization The deliverable outcomes by the FYP students are: (1) Preprocessed Dataset & Feature Set containing cleaned and annotated operational data with engineered features. (2) Trained Deep Learning LSTM-based forecasting model with code and documentation. (3) Report containing performance comparison with baseline methods and recommendation for deployment. (4) Prerequisite: Knowledge of Python. Prior background in machine learning, and deep learning frameworks will be beneficial
Student Workload Distribution	Student 1: data acquisition, preprocessing, and model implementation. Student 2: model training, hyperparameter tuning, and performance evaluation.
Supervisor	Dipti Srinivasan, E-mail: dipti@nus.edu.sg
Laboratory Work	Computer
No. of students	2
CA1 requirements	Conduct literature review; gather or simulate historical data; perform preprocessing and feature selection; develop baseline LSTM model.

CA2 requirements	Train, tune, and evaluate deep learning models; benchmark results; finalize report.

ID: SP32	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Development of Mobile Gait Assessment system – Sensor based approach
Summary (200 – 400 words)	Mobility and walking function is a key reflector of health status. This is true to the extent that walking speed has been designated the sixth vital sign, as it accurately reflects functional status and overall health for a wide population of patients. Tools and outcome measures for the accurate evaluation of mobility and walking ability are required to aid in accurate diagnosis and targeted rehabilitation interventions for mobility function. Surrogate measures such as measures of strength and endurance, do not accurately reflect walking ability. Gait evaluation is key to guide management and rehabilitation of mobility function. The **project scope** includes: (1) Literature review on gait modelling and assessment; (2) To develop sensor-based solution for gait assessment Students are expected to develop the following skills (**learning outcome**): (3) To understand basic knowledge of Telehealth and its key components; (4) To be skilled in embedded systems; The achievable outcomes by the FYP students are: Development of a sensor-based Gait algorithms. This project can take up to 2 students: Students 1 & 2: focus on sensor-based solution. There are various gait parameters that we would like to extract and students can focus on different parameters. This project is suitable also for you to continue during your 1 year Master programme in NUS. **Prerequisite: Must have some experiences in embedded systems**
Student Workload Distribution	Student 1: work together to setup software/hardware platform, student 1 will primarily focus on heal-strike angle and explore methods to validate the method.
	Student 2: work together to setup software/hardware platform, student 2 will primarily focus on toe-off angle, timing duration of different phases of TUG.
Supervisor	Arthur Tay, eletaya@nus.edu.sg
Laboratory Work	Computer
No. of students	2
CA1 requirements	Literature review and hardware development. Develop algorithm.
CA2 requirements	Development of gait assessment system

ID: SP33	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Machine Learning Approaches for Seizure Prediction from EEG Signals
Summary (200 – 400 words)	This is a state-of-the-art project in healthcare domain that uses machine learning. The healthcare sector is highly influenced by technological innovations. Seizure prediction is a critical healthcare problem that can improve quality of life for people with epilepsy. EEG signals hold pre-ictal (before seizure) patterns that can be exploited using ML/DL to issue early warnings. This project evaluates existing methods and proposes novel models for robust seizure prediction. Project involves pre-processing steps like, Bandpass filtering (e.g., 0.5–70 Hz), Artifact removal (e.g., Independent Component Analysis), Epoch segmentation (e.g., 10s or 30s windows), Normalization and baseline subtraction. Project involves pre-processing steps like, Bandpass filtering (e.g., 0.5–70 Hz), Artifact removal (e.g., Independent Component Analysis), Epoch segmentation (e.g., 10s or 30s windows), Normalization and baseline subtraction. Then the students can explore implementing CNN, LSTM, hybrid models, and data augmentation like time warping, etc. Lot of scope for proposing novel techniques and performance evaluations to be made using specific metrics like, sensitivity, false prediction rate, ROC-AUC, confusion matrix, etc. We need to demonstrate a high accuracy in the classification of low-risk and high-risk patients. Relevant reading material, data and exact reading materials are readily available. The ***project scope*** includes: (1) Literature review of EEG data recognition and anomaly detection methods; (2) Use of Machine learning tools to implement the methods; (3) To evaluate the performance of the methods and perform a comparative study. Students are expected to develop the following skills ***(learning outcome***): To understand basic knowledge of EEG recognition and anomaly detection process & methods To evaluate a given EEG recognition method and to use appropriate metrics The ***achievable outcome*** by the FYP students for the CA assessment are: (1) To identify and implement EEG signal recognition and anomaly detection methods (2) Performance Evaluation - influencing parameters; accuracy of prediction. (3) To use any hybrid techniques to cross-validate the earlier methods. **Expected Pre-req Skills** – Python-Healthcare related Python packages/Machine learning packages; must be able to interpret and analyse data. If there are two students to work on the project, each student should carry out two different anomaly detection methods for a given dataset and perform all-to-all comparison.
Student Workload Distribution	Student 1: A base model – joint effort, one individual learning model and implementation, compare with Student 2; Can try any novel hybrid method;
	Student 2: A base model – joint effort, one individual learning model and implementation, compare with Student 1; Can try any novel hybrid method;
Supervisor	A/Prof Bharadwaj Veeravalli, elebv@nus.edu.sg
Laboratory Work	Software/Laptop
No. of students	2
CA1 requirements	Project scope (1) and (2); Students must be familiarize themselves on the existing EEG recognition and Anomaly detection algorithms/methods; Relevant programming tools must be learnt and must demonstrate small scale relevant examples
CA2 requirements	To implement and evaluate the performance of hybrid/novel ML based anomaly detection methods – demonstration of a full-fledged implementation with relevant dataset.

ID: SP34	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Smart heart rate monitoring device based on advanced magnetic sensor
Summary (200 – 400 words)	Accurate and continuous pulse monitoring is essential in health tracking, fitness applications, and wearable technology. Traditional optical methods like photoplethysmography (PPG) are widely used but are often affected by motion artefacts and ambient light. Magneto-plethysmography (MPG), which uses magnetic sensors to detect pulse-induced changes in a static magnetic field, offers a promising, low-power, motion-resilient alternative. This project aims to develop a compact, low-cost, and motion artefact-resistant MPG pulsometer for continuous pulse rate monitoring. The system comprises a small permanent magnet placed near a pulse point (finger or wrist) and a high-sensitivity magnetic sensor. The magnetic flux, modulated by pulsatile blood flow, is captured and processed to extract pulse signals. Two students will work collaboratively: one focusing on a finger-based detection approach, and the other on a wrist-based detection approach. Both approaches will be compared in terms of accuracy, noise resilience, and wearability. The **project scope** includes: 1) Review MPG-based finger and wrist pulse sensing techniques. 2) Define hardware requirements and select suitable magnetic sensors and permanent magnets. 3) Design and build the sensing circuit to capture finger and wrist pulse signals. 4) Process the signal using microcontroller-based filtering and pulse detection algorithms. 5) Evaluate sensitivity and motion artefact in controlled and free-motion conditions. 6) Compare the results with PPG sensors. Students are expected to develop the following skills (**learning outcome**): 1) Understand principles of MPG sensing and bio-signal acquisition. 2) Develop hardware skills in circuit design, sensor integration, and low-noise signal capture. 3) Apply signal processing techniques to extract reliable pulse signals under motion. 4) Compare system design trade-offs between finger and wrist implementations. 5) Gain experience in prototyping wearable sensing systems. The deliverable outcomes by the FYP students are: 1) A functional prototype of MPG pulse sensor for both finger- and wrist-based detection. 2) Signal processing algorithms to extract pulse rate from magnetic field variations. 3) Comparative evaluation of finger and wrist approaches in terms of accuracy, noise resilience, and wearability. 4) Final project report and demonstration summarizing design, methodology, results, and key findings. **Prerequisite:** Prior experience of hardware and software implementation is a must.
Student Workload Distribution	Student 1: Build and test the finger-based MPG sensor setup, extract pulse signals, and support performance comparison and reporting.
	Student 2: Build and test the wrist-based MPG sensor setup, extract pulse signals, and support performance comparison and reporting.
Supervisor	Wu Yihong; email: elewuyh@nus.edu.sg
Laboratory Work	Bench-top instruments, electronic components, magnetic sensor, computer
No. of students	2
CA1 requirements	Preparation of technical specification and block diagram of MPG sensor, design and fabrication of the sensing circuits, design and implementation of hardware and software for processing the detected signals.
CA2 requirements	Testing, evaluation and improvement of the MPG sensor at system level; demonstration of real-time HR and BP monitoring.

ID: SP35	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Design and Implementation of a Multi-Protocol IoT Gateway
Summary (200 – 400 words)	The explosive growth of IoT ecosystems demands gateways capable of handling diverse wireless communication protocols. To support heterogeneous networks and reduce interoperability challenges, this project proposes a multi-protocol hardware gateway that integrates the Nordic nRF52840 platform and Huawei's NearLink protocol to enable seamless interaction between BLE, Zigbee, Thread, and NearLink-compatible devices. The **project scope** includes: (1) Literature review of IOT communication protocols; (2) hardware interface and integration for nRF52840 and/or NearLink modules; (3) Firmware development supporting protocol switching and coexistence, inter-protocol data bridging; (4) Real world demonstration involving at least two protocols; (5) Documentation and usability analysis. Students are expected to develop the following skills (**learning outcome**): (1) To understand and apply multiple IoT protocols; (2) To develop embedded firmware using Zephyr RTOS or Nordic SDK; (3) To be skilled to interface and communicate between multiple wireless modules via UART/SPI/I2C; (4) To be familiar with protocol abstraction and switching mechanisms. (5) To be able to design an **interface** for gateway communication using MQTT or REST The deliverable outcomes by the FYP students are: (1) Fully functional IoT gateway capable of communicating over BLE, Zigbee, Thread, and NearLink. Integrated onto a development board or custom PCB; (2) Unified and modular firmware supporting protocol switching or coexistence. Implemented using Zephyr RTOS or Nordic SDK; (3) Quantitative analysis of latency, power consumption, packet reliability, and throughput for each supported protocol. Includes comparison between NearLink and legacy protocols; (4) Full technical documentation including system architecture, interfaces, protocol mapping, testing methodology, and code annotations; **Prerequisite:** Prior experience of hardware implementation and digital communication is a must.
Student Workload Distribution	Student 1: Work on the hardware and software based on nRF52840. Student 2: Work on the hardware and software based on NearLink Technology.
Supervisor	Zhang Jianwen, elezhan@nus.edu.sg
Laboratory Work	Bench-top instruments, computer.
No. of students	2
CA1 requirements	Preliminary design and prototype with hardware and software development. Simple demonstration.
CA2 requirements	Demonstrate the implemented gateway with a testing environment with at least two different protocols such as BLE-to-NearLink bridging in a smart home or industrial use case. Well-structured and version-controlled source code with README and build instructions.

ID: SP36	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Learning Distributed Resilient Safe Control for Multi-Quadrotor Systems
Summary (200 – 400 words)	Multi-quadrotor systems are widely used in autonomous robotics, especially for tasks such as search and rescue and area coverage. Modern multi-quadrotors systems increasingly rely on networked communication and real-time information sharing, making them vulnerable to cyber-attacks such as denial-of-service. These attacks can disrupt control signal updates, leading to potential collisions and degraded mission performance. This project develops learning-based distributed resilient safe controllers for multi-quadrotor systems. Deep reinforcement learning will be employed to train distributed safe control policies capable of maintaining both individual and collective safety even under denial-of-service attacks. Students will implement a training pipeline in a simulated multi-quadrotor environment and evaluate their policies on tasks including coordinated trajectory tracking and area coverage missions. The objective is to ensure that multi-quadrotor can complete their assigned task safely even in the presence of communication disruptions. The project scope includes: (1) Literature review on quadrotor dynamics and deep reinforcement learning. (2) Design and implementation of a deep RL-based distributed safe control framework using modern learning algorithms (e.g., PPO, SAC) and safe control method (e.g., control barrier function). (3) Training safe neural policies for tasks including trajectory tracking and area coverage without collisions. (4) Performance evaluation and visualization of learned distributed controllers across different flight scenarios. Students are expected to develop the following skills (learning outcome): (1) To understand quadrotor dynamics and distributed controller design. (2) To be familiar with model-based and learning-based safety-critical controllers. (3) Learn how to design and conduct simulation-based experiments for robotic systems. (4) To be skilled at training of neural networks using modern learning algorithms (e.g., PPO, SAC). The deliverable outcomes by the FYP students are: (1) Successful development of simulation environment and training pipeline, design of reward, 3D visualization of flight. (2) Demonstration of learning-based distributed resilient safe controller. (3) Quantitative simulation results analysis. **Prerequisite:** Solid background in control, robotics, and machine learning. Proficiency in Python, PyTorch, and experience with simulators such as Isaac Gym or Gazebo is recommended.
Student Workload Distribution	Student 1: on trajectory tracking while avoiding collisions task Student 2: on area coverage while avoiding collisions task
Supervisor	ZHAO Lin, zhaolin@nus.edu.sg
Laboratory Work	Computer with GPU RTX 4080 or better is required.
No. of students	2
CA1 requirements	Training pipeline design, algorithm implementation, quadrotor dynamics review, and preliminary simulator development, etc.
CA2 requirements	Comprehensive simulation demo/animation of the learned controller, success rate analysis, failure case analysis.

ID: SP37	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Modeling and Optimization of Wireless Power Transfer
Summary (200 – 400 words)	Wireless power transfer (WPT) is revolutionizing energy delivery for biomedical devices, consumer electronics, and industrial systems. However, achieving efficient, compact, and reliable WPT requires deep understanding of electromagnetic coupling and system dynamics. This project focuses on building accurate circuit and field-level models to simulate WPT systems, studying key parameters like impedance matching and coupling efficiency. Using tools such as MATLAB, HFSS, or CST, students will explore optimization strategies to boost system performance. The **project scope** includes: (1) Study the theoretical foundations of WPT and related design challenges; (2) Develop circuit-level and numerical simulation models to analyze energy transfer; (3) Simulate performance using software like HFSS, CST, or MATLAB; (4) Explore optimization methods to enhance transfer efficiency and system stability. Students are expected to develop the following skills (**learning outcome**): (1) Master the physical and theoretical principles underlying WPT; (2) Gain practical skills in modeling and simulating complex EM systems; (3) Analyze critical parameters such as system efficiency and impedance matching; (4) Learn to optimize designs for real-world performance improvements; The deliverable outcomes by the FYP students are: (1) Literature review on WPT theory and existing technologies; (2) Circuit and field-level simulations with documented performance analysis; (3) Comparative study of circuit vs. field models highlighting strengths and limitations. **Prerequisite:** (1) Basic understanding of electromagnetics or circuit theory; (2) Familiarity with simulation tools (MATLAB/Simulink, ANSYS, CST); (3) Interest in WPT and its advanced applications.
Student Workload Distribution	Student 1: Literature review, development of circuit simulation, design of optimization strategy, comparison with Student 2's work.
	Student 2: Literature review, development of numerical simulation, optimization of field-level design, comparison with Student 1's work.
Supervisor	Zhao Zhenyu, zhaozy@nus.edu.sg
Laboratory Work	Simulation software: MATLAB/Simulink, ANSYS HFSS, CST Studio.
No. of students	2
CA1 requirements	Literature review, problem analysis, initial simulation models, and early results.
CA2 requirements	Optimized models with validation, final report, and project presentation.

ID: SP38	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Non-Invasive Glucose Detection from Sweat Using GaN HEMT Biosensors
Summary (200 – 400 words)	Diabetes management requires frequent glucose monitoring, however traditional blood-based methods are invasive and inconvenient. Recent developments in biosensors have enabled non-invasive glucose detection using alternative biofluids like sweat, urine and saliva. Gallium Nitride High Electron Mobility Transistors (GaN HEMTs) offer high sensitivity, stability, and miniaturization potential, making them ideal for wearable biosensing. Integrating GaN HEMTs with an electrochemical cell can enhance selectivity and accuracy for glucose detection in sweat, addressing key challenges in non-invasive monitoring. This project aims to develop a portable system consists of GaN HEMT biosensors with Arduino-based portable characterization tool with smartphone communication capability. The system will enable real-time, user-friendly glucose tracking, reducing discomfort for diabetic patients. By leveraging GaN HEMT's superior electronic properties and Arduino's versatility, the project seeks to advance wearable health technology while ensuring affordability and scalability. The **project scope** includes: (1) Literature review of biosensors, GaN HEMTs and its use as biosensors, portable measurement systems and relevant technologies; (2) Design, fabrication and characterization of biosensors based on GaN-HEMTs; (3) Design, setup and testing of portable measurement system based on Arduino; (4) Integration of biosensors and portable measurement system for glucose detection. Students are expected to develop the following skills (**learning outcome**): (1) To understand working principles of electronic devices and biosensors; (2) To be skilled on the device fabrication and characterization; (3) To be skilled on embedded system development with wireless communication and basic mobile application development; (4) To be skilled on integration of sensing technologies and portable measurement system. The deliverable outcomes by the FYP students are: (1) To design and test functional GaN-HEMT based biosensors; (2) To build and test portable Arduino-based measurement system; (3) To measure glucose using the biosensor and portable measurement system; (4) To improve the device and system design based on the testing. **Prerequisite:** Prior experience of software and hardware implementation is a must.
Student Workload Distribution	Student 1: on device/biosensor, design, fabrication and characterization of biosensors using GaN HEMT and for glucose detection.
	Student 2: on portable Arduino-based measurement system with communication between device and smartphone, data collection and analysis, and integration with biosensors.
Supervisor	Zhu Chunxiang, E-mail: elezhucx@nus.edu.sg
Laboratory Work	Bench-top instruments, computer, impedance analyzer
No. of students	2
CA1 requirements	Design and setup of GaN HEMT based biosensors and portable measurement system. Simple demonstration.
CA2 requirements	Integration of GaN based biosensors and portable measurement system for glucose biomarker detection.

ID: SP39	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Design of a Wearable EOG Acquisition System for Hands-Free Game and Device Control
Summary (200 – 400 words)	Electrooculography (EOG) is a promising technique for hands-free control interfaces, with applications in assistive technology, gaming, and smart devices. Previous implementations have relied on off-the-shelf bio-amplifier boards, which often result in bulky setups with limited wearability. This project aims to design and build a custom miniaturized EOG acquisition system integrated into a wearable form factor, enabling comfortable long-term use. The system will consist of a student-designed analog front end (AFE) to acquire and amplify EOG signals, with onboard filtering and digitization. The hardware will be integrated into a wearable platform such as eyeglass frames or a soft headband, ensuring secure electrode placement while maintaining user comfort. Processed signals will be streamed to a microcontroller or wireless module for interpretation, allowing control of interactive applications such as games or smart home devices. The **project scope** includes: (1) Literature review on EOG signal acquisition, wearable low-power circuits; (2) Design and fabrication of a custom PCB integrating instrumentation amplifiers, filters, and ADCs in wearable form factor with electrode placement and cable routing) (3) Software development for signal filtering, calibration, and real-time control mapping. (4) Integration of system into single prototype and user testing. Students are expected to develop the following skills (**learning outcome**): (1) To be familiar with analog bio-signal circuit design and PCB fabrication; (2) To be familiar with embedded firmware development and signal processing; (3) To be familiar with hardware software integration for wearable devices; The deliverable outcomes by the FYP students are: (1) A wearable prototype with integrated electrodes and signal processing. (2) Custom miniaturized EOG acquisition board. (3) Demonstration of controlling games or devices. **Prerequisite:** Comfortable with analog circuit design, PCB tools (e.g., Altium, KiCad), and microcontroller programming.
Student Workload Distribution	Student 1: Analog front end circuit design, PCB layout, hardware testing.. Student 2: Firmware and signal processing, wearable form factor design, integration and evaluation.
Supervisor	Chua Dingjuan, elechuad@nus.edu.sg
Laboratory Work	PCB fabrication, soldering stations, microcontrollers, signal analysis equipment (oscilloscope, multimeter), 3D printer for housing.
No. of students	2
CA1 requirements	Initial Analog Front End schematic, simulation, and breadboard prototype integrated with basic signal acquisition.
CA2 requirements	Completed wearable hardware with custom PCB and firmware, demonstrated in a game control scenario with evaluation report.

ID: SP40	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Development of satellite system simulator for rapid payload development and integration
Summary (200 – 400 words)	The Satellite Technology and Research (STAR) Centre has developed four 12U microsatellites, Lumelite-1 to Lumelite-4. While Lumelite-4 was launched in April 2023, Lumelite-1 to Lumelite-3 are scheduled for launch by the end of 2025. A major challenge in satellite development is that payload system integration is constrained by the access to actual satellite hardware. The cost of assembling a full hardware testbed is high. As a result, payload development usually relies on a simple onboard computer (OBC) simulator with limited capabilities. It often leads to unforeseen software bugs and hardware issue when the payload is interfaced with the complete satellite system. This project aims to develop a comprehensive satellite system simulator that emulates the data interfaces and communication protocols between each satellite subsystem and hardware components. The simulator will support a range of standard interfaces, which includes I2C, CAN, UART, RS422, and RS232. This will allow a realistic modeling of interactions between subsystems that may use different communication standards. In addition, the simulator will replicate various communication anomalies that could occur within a satellite system, such as packet transmission and reception error due to network congestion across multiple subsystems. **The project scope includes:** **(1) Literature review of satellite subsystems;** (2) Literature review of data interface such as I2C, CAN, UART, RS422 and etc; (3) Study the different hardware and payload of satellite; (4) Develop python-based satellite subsystems simulator, and (5) Incorporate communication error, protocol mismatch and subsystem interaction into simulator. Students are expected to develop the following skills (**learning outcome**): (1) To understand the functionality of each satellite subsystem; (2) To be familiar with different data interface protocol; (3) To be familiar with the embedded system communication process; (4) To be skilled at python programming; The deliverable outcomes by the FYP students are: (1) A python-based satellite system simulator; (2) Integrate one hardware component to the simulator via RS232 / UART / CAN or any other protocol, and (3) Demonstrate the communication between each subsystem simulator that mimics the real data communication protocol; **Prerequisite:** Knowledge of data interface protocol and python programming.
Student Workload Distribution	Student 1: On development of OBC simulator and third satellite subsystem simulator or several hardware components.
	Student 2: On development of second satellite subsystem simulator with possible additional hardware component.
Supervisor	GOH Shu Ting, shuting@nus.edu.sg
Laboratory Work	Oscilloscope, computer, 3D printer.
No. of students	2
CA1 requirements	Demonstrate the one subsystem communication with another subsystem
CA2 requirements	Demonstrate the interfacing across multiple subsystems, include additional hardware component.

ID: SP41	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Design of Test Platform for NAND Flash Memory Chips based on MCU/FPGA
Summary (200 – 400 words)	NAND flash memory has been widely used for data storage due to its high density, high throughput, low cost, and low power. However, as flash memory manufacturers scale to more advanced process technologies and store more bits per cell, the reliability and endurance of flash memory are decreasing. In this project, the aim is to design and implement a test platform for quick, accurate, and comprehensive characterization of flash memories. The project scope includes: (1) Literature review of NAND flash memory development and working principle (2) To understand the datasheet of NAND flash and design an algorithm to achieve efficient read and write operations on flash and block erase operations (3) To propose an error patterns detection method and a bad block management policy based on real error patterns, which can improve the lifetime of NAND flash (4) To design a method to quickly detect the endurance of NAND flash, and study the variation law of the number of original error bits, erase time, and programming time as the number of program/erase (P/E) operations increases Through this project, students are expected to develop the following skills (learning outcome): (1) To understand the basic working principle and advantages of NAND flash memory (2) To be familiar with the method to read and write memory chips (3) To be skilled at MCU/FPGA programming (4) To be familiar with basic circuit design (5) To be skilled at PCB design The deliverable outcomes by the FYP students are: (1) To complete the simulation on computer and test platform on PCB (2) To achieve fast simultaneous measurement of multiple NAND flash chips (3) To adapt to different packages and different types of NAND flash chips by replacing the test socket (4) To design a clear user interface to display test data and results (5) To write good technical reports and possibly submit papers to international conferences or journals
Student Workload Distribution	Student 1: Student 1 completes the deliverables 1 and 3 Student 2: Student 1 completes the deliverables 2 and 4
Supervisor	Gong Xiao; elegong@nus.edu.sg
Laboratory Work	Bench-top instruments, Computer and software to support simulation
No. of students	2
CA1 requirement	Review of NAND flash memory development and working principle, and build hardware to realize basic operation functions
CA2 requirement	To build the hardware and design an algorithm to realize more advanced operation functions, including achieve efficient read and write operations on flash and block erase operations

ID: SP42	This FYP proposal is for 3+1+1 students at NUSRI Suzhou
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Fractional-N Sampling PLL with linear slope generator
Summary (200 – 400 words)	Sampling PLL has demonstrated potential for low in-band phase noise as well as low reference spur. In this project, we will implement fractional-N sampling PLL with embedded phase interpolator within linear slope generator. The **project scope** includes: (1) Literature review of sampling PLL architecture; (2) Design and simulate the sampling PLL; (3) Evaluate the performance and benchmarked with other sampling PLL design; Students are expected to develop the following skills (**learning outcome**): (1) To understand the sampling PLL architecture; (2) To develop EDA tool usage skillset; (3) To develop schematic design and circuit simulation skill; (4) To be able to evaluate PLL performance; The achievable outcomes by the FYP students are: (1) A completed PLL design with transistor level schematic; (2) A complete simulation results to evaluate the distributed amplifier performance. **Prior experience of software and hardware implementation is a must.** If there are two students to work on the project, each student should carry out different part of the design, and achieve the above-mentioned outcomes. **Prerequisite:** Prior experience of EDA, such as cadence, is a must.
Student Workload Distribution	Student 1: Work on the VCO, frequency divider and linear slope generator Student 2: Work on DS modulator, sampling PD, loop filter and frequency locked loop
Supervisor	Heng Chun Huat, elehch@nus.edu.sg
Laboratory Work	Not applicable
No. of students	2
CA1 requirements	Review of sampling PLL and various blocks
CA2 requirements	Implementing the sampling PLL

ID: SP43	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Quantum gate emulation with LCR circuits
Summary (200 – 400 words)	In this project, we will design LCR electrical circuits to emulate all the universal quantum gates (Hadamard, CNOT and phase shift). We will determine the optimum time evolution of the circuit components to achieve the best quantum outputs. We will compare the outputs with the publicly available IBM Quantum Computing tool. Finally, we will design and characterize realistic LCR quantum gate circuits using the LTspice library which incorporates parasitic components as well as tolerance range of normally available circuit components. The project scope includes: xvi) Literature review of research articles covering LCR circuits emulating quantum gates xvii) Apply Kirchhoff's laws to verify the output the LCR circuits emulating quantum gates xviii) Optimizing the time evolution of the LCR circuits xix) Modelling the LCR circuits with circuit simulation software e.g. LTspice xx) Extending beyond the basic quantum gates, e.g. to non-unitary quantum gates Students are expected to develop the following skills (learning outcome): xi) Realistic circuit simulations using simulation packages such as LTspice xii) Analytical and numerical programming skills with Mathematica or Matlab xiii) Able to design and implement quantum gates based on LCR circuits The deliverable outcome by the FYP students for the CA assessment are: v) General design and characterization of LCR-based quantum gate circuits vi) Optimization and verification of quantum gate operations If there are two students to work on the project, each student should take charge of different aspects of the circuit design, circuit optimization and LT Spice simulation.
Student Workload Distribution	Student 1: On theory and circuit design, circuit characterization of LCR circuits performing quantum gate operations
	Student 2: On circuit simulation, PCB design, circuit implementation of of LCR circuits performing quantum gate operations
Supervisor	Mansoor Bin Abdul Jalil
Laboratory Work	Matlab, Mathematica and LTspice software, PCB design and circuit characterization
No. of students	2 (not more than 2 students for each project)
CA1 requirements	General theory and implementation of basic LCR circuits
CA2 requirements	To achieve the goals set out in Deliverables (i) and (ii).

ID: SP44	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Intelligent piezoelectric tactile sensors & applications in human-machine interface for robotic control
Summary (200 – 400 words)	Tactile sensing is essential for building intuitive human-machine interface (HMI) or enhancing robot manipulations. Piezoelectric tactile sensors, which is highly-integrated with a miniature form factor, are especially good at measuring dynamic (high frequency) and minute tactile information, complementing human's mechanoreceptors. This project aims to fabricate a piezoelectric tactile sensor-based human machine interface or robotic system. Compared to tradition solutions, the system can capture high frequency and minute tactile signal, surpassing the sensing ability of humans. Moreover, combining with machine learning techniques, the system should perform sophisticated downstream tasks like 3D force sensing, object identification, etc. The **project scope** includes: (1) Literature review of piezoelectric tactile sensors and their applications; (2) Hardware study consisting of data measurement (e.g., oscilloscope) and processing devices, characterization of piezoelectric tactile sensors, data transmission hardware and protocols, etc.; (3) Software study with data analysis, machine learning, CAD design, etc.; (4) Designing appropriate application scenarios for demonstration. Students are expected to develop the following skills (**learning outcome**): (46) To understand the principles of piezoelectric tactile sensors; (47) To be familiar with data measurement and processing devices; (48) To be familiar with basic circuit design (49) To be skilled at characterization of piezoelectric tactile sensors; (50) To be skilled at machine learning-based signal processing; The deliverable outcomes by the FYP students are: (1) To perform the characterization of piezoelectric tactile sensors; (2) To build the sub-system for data recording and transmission; (3) To process the tactile information with machine learning; (4) To demonstrate the function of tactile sensors in practical applications; **Prerequisite:** Prior experience with data measurement/processing devices is a must; basic knowledge in circuits and microcontrollers (e.g., Arduino) is a must; prior experience with machine learning, CAD software, 3D printing is a plus.
Student Workload Distribution	Student 1: tactile sensor characterization, data collection and pre-processing (e.g., denoising, amplifying, etc.), development of human-machine-interface
	Student 2: tactile sensor characterization, wireless data transmission, data analysis with machine learning; machine learning for data collected by human-machine-interface
Supervisor	Chengkuo Lee, elelc@nus.edu.sg
Laboratory Work	Bench-top instruments, characterization devices, 3D printers (potential)
No. of students	2
CA1 requirements	Tactile sensor characterization, basic signal processing and transmission.
CA2 requirements	Machine learning-based data analysis and demonstration of applications.

ID: SP45	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Title of Project	Innovative application of low-cost radar modules
Summary (200 – 400 words)	The objective of the project is to develop innovative applications of low-cost radar modules. Low-cost radar modules typically cost a few dollars up to a few hundred dollars. An example of a low-cost radar module is the HB-100, and an example of an application of the HB-100 is the SEN0192 module. The HB-100 uses the Doppler effect to detect movement. These modules can be used, for example, to detect moving people and automatically open a door, The objective of this project is to develop innovative applications of the low-cost radar modules. An example could be a music instrument in which the movement of hands is translated into sound. The **project scope** includes: (1) Literature review of radar principles, including the Doppler effect; (2) Review of low-cost radar modules; (3) Development of several innovative concepts using low-cost radar modules; (4) Selection of concept for development; (5) Development and demonstration of an innovative application. Students are expected to develop the following skills (**learning outcome**): (51) To understand radar scattering mechanisms and the Doppler effect; (52) To understand the functional behavior of the selected radar module; (53) To apply (Doppler) radar signal processing; (54) To develop innovative concepts for applications of radar modules; (55) To fabricate and test an innovative application. The achievable outcomes by the FYP students are: (1) Development of several concepts of innovative applications of radar modules; (2) Fabricated and tested application of radar modules; (3) Possibly a conference contribution. . This project requires two students who are keen to work together on the development of innovative applications of low-cost radar modules.
Student Workload Distribution	Student 1: Develop the innovative application, test the radar module, obtain experimental data
	Student 2: Develop the innovative application, develop the controller and the software, test the application.
Supervisor	Koen Mouthaan k.mouthaan@nus.edu.sg
Laboratory Work	Bench-top instruments, testing of radar modules
N0. of students	2
CA1 requirement	Literature review, familiarization with low-cost radar modules, testing of radar module;
CA2 requirement	Selection of concept, demonstration of innovative application of radar module.

ID: SP46	This FYP proposal is for 3+1+1 students at NUSRI Suzhou
Academic Year	AY 2023/2024 (September 2023 – May 2024)
Title of Project	Single-phase Fast-charging Converter for Li-ion Batteries
Summary (200 – 400 words)	Li-ion batteries are ubiquitous in today's consumer electronics and electric vehicles, powering everything from smartphones and laptops to electric cars and power tools. Their widespread adoption is largely due to their high energy density, long cycle life, and relatively low self-discharge rates. However, one of the most significant challenges facing Li-ion battery technology is the charging time, which remains a key performance indicator for both manufacturers and end-users. The current industry standard for charging, known as the constant-current-constant-voltage (CCCV) method, involves charging the battery at a fixed current until a set voltage is reached, after which the voltage is held constant and the current gradually decreases. While this approach is safe and well-understood, it inherently limits the maximum charging speed, resulting in longer wait times for users. In response to this limitation, recent research has explored the use of non-linear voltage charging algorithms, which dynamically adjust the charging voltage and current based on the battery's state and characteristics. These algorithms have shown promise in significantly reducing charging times while maintaining battery health and safety. The objective of this project is to build upon these advancements by designing and constructing innovative electric circuits and power converters specifically tailored for non-linear voltage charging of Li-ion batteries. The project will focus on developing a prototype charging system for consumer electronics, such as smartphones, that integrates these advanced algorithms. This will involve circuit design, simulation, hardware implementation, and experimental validation to ensure both rapid charging and safety. By optimizing both the charging protocol and the supporting hardware, the project aims to deliver a practical solution that can be readily adopted in next-generation consumer devices. Ultimately, the successful completion of this project could lead to a substantial reduction in charging times, greatly enhancing user convenience and supporting the continued growth of portable electronic technologies. The project scope includes: (1) Literature review of fast charging algorithms and Li-ion battery models; (2) Design a charging circuit for a 5000mAh battery pack; (3) Implement the fast charging algorithm onto the designed circuit; (4) Showcase a working power bank prototype. Students are expected to develop the following skills (learning outcome): (1) To be familiar with fast charging algorithm for Li-ion batteries; (2) To be familiar circuit design and embedded systems; (3) To become competent in power electronics. Expected outcomes by the students are: (1) Conduct a detailed literature review on non-linear charging algorithm; (2) Implement the fast-charging algorithm onto DSP controller; (3) Construct a prototype charging circuit; (4) Demonstrate a working design.
Supervisor	Jimmy Chih-Hsien PENG
Laboratory work	Circuit design, C programming
No. of students	2
CA1 requirement	Present the PCB design of the charging circuit and emulate the charging algorithm in DSP.
CA2 requirement	Showcase a working prototype equipped with fast charging algorithm.

ID: SP47	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	High-Temperature SiC three-phase two-level inverter
Summary (200 – 400 words)	Wide band gap (WBG) semiconductor devices are the future of high-density high-efficiency low cost and light wright power electronics. Three-phase 2-level inverter is popular for UPS, EVs, and many other applications. This project aims to analyse and design a SiC two-level three-phase inverter for EV applications. The project includes mathematical analysis, circuit design, implementation of modulation strategy, design of components, simulation, and hardware development and testing. The **project scope** includes: (1) Literature review of SiC two-level three-phase inverters (2) Differences in the design of Si and SiC based two-level three-phase inverters (3) High-temperature design study of SiC inverter for temperature range of 180-200^{o}C (4) Simulation of the 3-phase inverter with SiC parasitic (5) Thermal design at 180-200^{o} C, hardware development and testing Students are expected to develop the following skills (**learning outcome**): (1) To understand wide band gap semiconductor device and thermal characteristics (2) To be familiar with high temperature high-frequency SiC inverter operation (3) To be skilled at thermal analysis and design (4) To be skilled at hardware design, Sine inverter modulation, development and testing The deliverable outcomes by the FYP students are: (1) To demonstrate learning of thermal design and management of inverter for 180-200^{o}C (2) To improve and demonstrate the density, cost, and weight of the converter (3) To enhance the learning of sine inverter modulation, gate driver design, and training at high device switching frequency operation of SiC devices **Prerequisite:** Prior experience of hardware implementation is required.
Student Workload Distribution	Student 1: on circuit hardware development, thermal analysis, and design with SiC semiconductor devices.
	Student 2: on simulation, modulation implementation through programming, gate driver development. Testing, calculation, and benchmarking will be done together
Supervisor	Akshay Kumar Rathore, akshay.rathore@nus.edu.sg
Laboratory Work	Bench-top instruments, computer, power supplies, logic power supply, meters and scope
No. of students	2
CA1 requirements	Mathematical analysis, circuit design, thermal design, and simulation results
CA2 requirements	Preliminary prototype with hardware and software development. Simple demonstration.

ID: SP48	**This FYP proposal is for 3+1+1 students at NUSRI Chongqing**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Physics-Inspired Evolutionary Optimization for Complex Problem Solving
Summary (200 – 400 words)	Optimization is at the heart of both natural processes and modern computational technologies. From the formation of stable protein structures to the design of AI systems, optimization drives efficiency and functionality. However, many real-world problems such as the Knapsack Problem and the Traveling Salesman Problem (TSP) remain computationally intensive and difficult for traditional solvers. This project explores a novel direction by developing a hybrid optimization framework that combines physics-inspired concepts (e.g., energy minimization, entropy, thermodynamic transitions) with well-established evolutionary algorithms such as Genetic Algorithms and Simulated Annealing. The aim is to enhance convergence speed, solution quality, and robustness by embedding physical insights—such as equilibrium states or force dynamics—into heuristic search strategies. The hybrid algorithms will be implemented and tested on benchmark problems including TSP and Knapsack, which are widely used for evaluating optimization approaches. The project involves algorithm design, code implementation, performance evaluation, and comparative benchmarking against conventional optimization techniques. The outcome will include a modular and extensible optimization framework with demonstrated advantages in solving complex combinatorial problems. This approach can be extended in the future to tackle challenges in scheduling, logistics, and AI system design. The **project scope** includes: (6) Literature review of recent works; (7) Design hybrid optimization algorithms combining physics-inspired and evolutionary methods. (8) Implement and test algorithms on the Knapsack and TSP problems. (9) Benchmark performance against conventional optimization techniques. (10) Deliver a modular codebase and evaluation report Students are expected to develop the following skills (**learning outcome**): (56) Understand and apply nature- and physics-inspired optimization techniques. (57) Implement hybrid algorithms using Python and open-source libraries. (58) Evaluate optimization performance on benchmark problems. (59) Develop modular frameworks for extensible optimization The deliverable outcomes by the FYP students are: **(1)** Implemented algorithms with documentation. **(2)** Comparative analysis on Knapsack and TSP. **(3)** Report containing performance comparison with baseline methods methodology, findings, and insights for future extension. **Prerequisite:** Knowledge of Python. Prior background in algorithms, optimization, and heuristic methods will be beneficial
Student Workload Distribution	algorithm design and implementation of physics-inspired components, benchmarking, performance evaluation, and comparative analysis.
Supervisor	Dipti Srinivasan, E-mail: dipti@nus.edu.sg
Laboratory Work	Computer
No. of students	1
CA1 requirements	Review literature; formulate physics-inspired principles; implement base algorithms; begin preliminary testing..
CA2 requirements	Integrate hybrid framework; complete benchmarking; finalize documentation and analysis.

ID: SP49	This FYP proposal is for 3+1+1 students at NUSRI Suzhou
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Vision-based Tele-rehabilitation
Summary (200 – 400 words)	Due to Covid-19, many patients were not able to commute to hospitals and rehab centres for their rehabilitation which is critical for their recovery. Suspension of rehabilitation services may lead to detrimental long term consequences for patients, including those who have just undergone surgery or patients with acute musculoskeletal-related pain and injury. In addition, many patients who need rehabilitation are also worried about Covid-19 transmission in hospitals and hence unwilling to travel. The ability to monitor and measure accurately, comfortably, and continuously the progress of a patient undergoing rehabilitation, without injecting cumbersome wires or boxes into their activities, has the potential to revolutionize health therapies and services. In this work, we propose to develop a vision-based tele-rehabilitation system. The **project scope** includes: (1) Literature review of camera-based gait and motion monitoring systems; (2) To investigate the use of camera for rehab; (3) To investigate the use of Apple iPad for rehab; (4) Development of basic rehab exercises. Students are expected to develop the following skills (**learning outcome**): (1) To understand basic knowledge of Telehealth and its key components; (2) To be skilled at computer vision; (3) To be understands the need of rehabilitation ; The achievable outcomes by the FYP students are: Development of a vision-based rehabilitation. This project can take up to 2 students: Both students will work on setting up the software platform. Student 1: will focus on upper extremities exercises, 3rd person (healthcare/helper) detection. Student 2: will focus on lower extremities exercises, lighting conditions. **Prerequisite: Must have some experiences in embedded systems**
Student Workload Distribution	Student 1: Both students will work on setting up the software platform. Student 1: will focus on upper extremities exercises, 3rd person (healthcare/helper) detection. Student 2: Student 2: will focus on lower extremities exercises, lighting conditions.
Supervisor	Arthur Tay, eletaya@nus.edu.sg
Laboratory Work	Computer
No. of students	2
CA1 requirements	Literature review and software platform/hardware. Develop algorithm.
CA2 requirements	Development of vision-based rehabilitation

ID: SP50	This FYP proposal is for 3+1+1 students at NUSRI Suzhou
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Multi-Drone Path Planning Using Machine and Deep Learning Techniques in Dynamic Environments
Summary (200 – 400 words)	This is a state-of-the-art project in UAV and Multi-Drone path planning domain. Multi-drone coordination is essential for tasks like surveillance, search and rescue, package delivery, and precision agriculture. Traditional algorithms like A*, RRT*, and ORCA work well in static settings, but dynamic, uncertain environments require adaptive intelligence. This project explores ML/DL techniques for **collaborative, collision-free path planning** in such scenarios. We will attempt to explore - supervised learning, reinforcement learning, CNNs and transformer based techniques for different purposes. These include, training agents, multi-drone interaction modelling, visual or grid map based planning, etc. Research challenges include, multi-agent coordination without a central controller, collision avoidance, scalability issue, etc. We will attempt both ML-enhanced rule-based planning approach and RL-based multi-agent planning and compare. Several metrics can be used - time to goal, average path length, number of conflicts, etc. Python based tools and libraries can be used Open AI Gym for RL scaffolding, AirSim / Gazebo for drone simulation, etc. If time permits, we will also explore the use of **Voronoi representations** which can be highly useful and *strategically powerful*. Relevant reading material and basic reading materials are readily available. Data need to be generated as there are not many publicly available datasets. The ***project scope*** includes: 1) Literature review of multi-drone path planning methods; 2) Use of Machine learning tools to implement the methods; 3) To evaluate the performance of the methods and perform a comparative study. Students are expected to develop the following skills ***(learning outcome***): To understand basic knowledge of drones and multi-drone path planning methods To evaluate a given MD method and to use appropriate metrics The ***achievable outcome*** by the FYP students for the CA assessment are: (4) To identify and implement MD method using the methods specified above; signal (5) Performance Evaluation - influencing parameters; accuracy of prediction. (6) To use any hybrid techniques to cross-validate the earlier methods. **Expected Pre-req Skills** – Python related Python packages/Machine learning packages; must be able to interpret and analyse data. If there are two students to work on the project, each student should carry out two different anomaly detection methods for a given dataset and perform all-to-all comparison.
Student Workload Distribution	Student 1: A base model and an algorithm – joint effort, one individual learning model and implementation, compare with Student 2; Can try any novel hybrid method;
	Student 2: A base model and algorithm – joint effort, one individual learning model and implementation, compare with Student 1; Can try any novel hybrid method;
Supervisor	A/Prof Bharadwaj Veeravalli, elebv@nus.edu.sg
Laboratory Work	Software/Laptop
No. of students	2
CA1 requirements	Project scope (1) and (2); Students must be familiarize themselves on the existing algorithms/methods; Relevant programming tools must be learnt and must demonstrate small scale relevant examples
CA2 requirements	To implement and evaluate the performance of hybrid/novel ML based methods – demonstration of a full-fledged simulation with relevant dataset.

ID: SP51	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Smart Raindrop Sensor for Vehicles
Summary (200 – 400 words)	Raindrop sensors play a critical role in improving driver safety and convenience by enabling automatic windshield wiper activation. Traditional optical rain sensors often rely on reflectance changes caused by water droplets on the windshield. However, these systems can be limited by ambient light conditions, false triggering, and suboptimal accuracy in detecting varying rainfall intensities. To address these limitations, this project proposes the development of a smart raindrop sensor using custom-built hardware and enhanced signal processing algorithms, including machine learning (ML) techniques. This two-student team project will involve: 1) Prototyping a smart raindrop sensor using discrete optoelectronic components, including testing, benchmarking, and comparison with commercial systems, and 2) Developing intelligent algorithms based on signal features and machine learning to improve detection accuracy and estimate rainfall conditions). The **project scope** includes: 1) Review existing rain sensing methods and rain detection/classification techniques, including optical, alternative sensors, and machine learning approaches. 2) Design, build, and calibrate prototype sensors under various rainfall conditions. 3) Collect signal data, extract features, and benchmark sensor performance against commercial products. 4) Develop, test, and compare rule-based and machine learning models for rain detection and intensity estimation. 5) Deploy and evaluate lightweight ML models on embedded systems for practical applications. Students are expected to develop the following skills (**learning outcome**): 1) Understand key sensor technologies for environmental detection. 2) Gain experience in hardware prototyping and system integration. 3) Learn basics of signal processing and noise reduction. 4) Apply machine learning to real-world sensor data. 5) Evaluate trade-offs between different sensing methods and algorithms. The deliverable outcomes by the FYP students are: 1) A working prototype of a smart raindrop sensor built using discrete optoelectronic components. 2) Benchmarking and performance comparison of the prototype against commercial rain sensors. 3) Signal processing and machine learning algorithms for accurate raindrop detection and rainfall intensity estimation. 4) Final report and demonstration covering hardware design, algorithm development, test results, and key findings. **Prerequisite:** Prior experience of hardware and software implementation is a must.
Student Workload Distribution	Student 1: Build and test the raindrop sensor hardware; benchmark performance against commercial sensors; support integration and reporting.
	Student 2: Develop and test signal processing and ML algorithms for rain detection; analyze data and assist with reporting and demo (detailed task sharing to be worked out).
Supervisor	Wu Yihong; email: elewuyh@nus.edu.sg
Laboratory Work	Bench-top instruments, electronic components, LED, PD, computer
No. of students	2
CA1 requirements	Literature review, commercial sensor analysis, preliminary data collection, and proposal of feasible alternative sensing concepts.
CA2 requirements	Working prototype, validated sensor performance, machine learning algorithm tested, and benchmarking against commercial solutions.

ID: SP52	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Design and Simulation of Assisted GPS Spoofing for Research and Defensive Evaluation
Summary (200 – 400 words)	Global Navigation Satellite System (GNSS) spoofing poses a growing threat to critical systems such as drones, autonomous vehicles, and defense platforms. While traditional GPS spoofing has been widely studied, Assisted GPS (A-GPS) spoofing — which manipulates both satellite and network-assisted location data — remains less explored. This project proposes to simulate and analyze A-GPS spoofing attacks in a controlled lab environment for the purpose of evaluating system vulnerabilities and developing countermeasures. The project will involve designing a modular testbed using software-defined radio (SDR) and open-source GNSS tools to emulate spoofing scenarios. The testbed will include a GPS spoofing engine (e.g., using gps-sdr-sim and HackRF), an A-GPS assistance data emulator (e.g., spoofing SUPL, LTE, and Wi-Fi data), and various target devices (e.g., smartphones, GPS modules, UAVs) for testing. The **project scope** includes: (1) Literature review on GNSS and A-GPS spoofing techniques and defense strategies; (2) Development of spoofing tools for satellite and network assistance emulation; (3) Experimental analysis of spoofed impact on navigation systems; (4) Investigation of spoof detection methods such as sensor fusion or GNSS cross-checking; (5) Documentation and research dissemination. Students are expected to develop the following skills (**learning outcome**): (1) To understand GNSS architecture and spoofing vulnerabilities; (2) Proficiency in SDR programming and RF signal generation; (3) Experience in multi-layer spoofing and wireless protocol analysis; (4) Skills in experimental testing, data collection, and defense evaluation. The deliverable outcomes by the FYP students are: (1) A functional GPS + A-GPS spoofing simulation platform; (2) Spoofing scripts and SDR configurations; (3) Detailed performance report on spoofing effectiveness and system vulnerabilities; (4) Prototype defensive mechanisms and analysis of detection feasibility; (5) Final technical documentation and a research report or paper. (6) **Prerequisite:** Prior experience wireless communication, SDR programming, and embedded systems is recommended.
Student Workload Distribution	Student 1: Development of SDR-based GPS spoofing tools and lab-based signal testing. Student 2: Emulation of A-GPS assistance data and multi-device test automation.
Supervisor	Zhang Jianwen, elezhan@nus.edu.sg
Laboratory Work	Bench-top instruments, computer with GNU Radio and SDR toolchain.
No. of students	2
CA1 requirements	Working prototype of GPS spoofing testbed using SDR. Demonstration of spoofing on GPS module with location drift validation.
CA2 requirements	Fully integrated A-GPS spoofing simulation with cellular/Wi-Fi emulation, defensive mechanism test, detailed analysis report, and demonstration.

ID: SP53	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Control and Simulation of Inverted Co-axial Drone
Summary (200 – 400 words)	This project focuses on the control and simulation of an inverted co-axial rotor system mounted on a 2-DoF gimbal at the base of a rocket-like body. This platform serves as a testbed for simulating thrust vectoring control in reusable rocket landers, such as Space X Falcon 9. The system mimics how thrust direction influences rocket body orientation and stability during landing and transition phases. The project involves developing a dynamic model of the full system, exploring trajectory planning, and implementing both LQR-based controllers and learning-based control policies to stabilize and maneuver the system under various conditions. Simulations will be carried out in simple numerical environments (e.g., MATLAB or Python) for quick prototyping, and then in more realistic ROS + Gazebo + PX4. The project scope includes: (1) Literature review on powered descent of recyclable rocket, co-axial rotor drone modelling and gimble control. (2) Modeling of the inverted co-axial drone system and derivation of dynamics equations, representation of 3D rotation, 3D rigid body motion modelling, etc. (3) Implementation of trajectory planning strategies for upright stabilization, lateral motion control, and soft landing maneuvers. (4) Design and simulation of LQR and model-based controllers. (5) Development and training of learning-based control policies (e.g., deep RL). (6) Simulation setup in ROS/Gazebo with PX4 for hardware-aligned validation. Students are expected to develop the following skills (learning outcome): (1) Understand the dynamics of thrust-vectoring systems and co-axial rotor modeling. (2) Learn trajectory planning and optimal control techniques (e.g., LQR). (3) Gain hands-on experience with learning-based control design (e.g., policy learning, neural controllers). (4) Develop skills in ROS/Gazebo/PX4-based simulation and controller deployment for aerial platforms. The deliverable outcomes by the FYP students are: (1) A complete simulation pipeline including both model-based and learning-based controllers. (2) Dynamic modeling and trajectory generation tools for thrust-vectoring rocket systems. (3) ROS-Gazebo-PX4 simulation platform for future hardware transfer. (4) Comparative analysis of controller performance under different flight scenarios. **Prerequisite:** Solid background in dynamics, control theory, and programming (Python/C++). Familiarity with MATLAB, and ROS/PX4 simulation tools is highly recommended.
Student Workload Distribution	Student 1: will focus on system modeling, trajectory planning, and design of LQR and classical controllers; implement numerical simulations and validate stability and tracking performance.
	Student 2: will focus on learning-based control policy design, simulation in ROS/Gazebo/PX4, and evaluation of control robustness and real-time feasibility for hardware alignment.
Supervisor	ZHAO Lin, zhaolin@nus.edu.sg
Laboratory Work	Computer with GPU RTX 4080 or better is required.
No. of students	2
CA1 requirements	Derivation of dynamic model, initial controller implementation (e.g., LQR), and preliminary simulation environment and simulation model development.
CA2 requirements	Comprehensive simulation demo/animation of inverted co-axial drone control using model-based and learning-based controller. A working ROS-Gazebo simulation platform aligned with PX4 for sim-2-real transfer.

ID: SP54	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Electromagnetic Interference Filtering Inductor Optimization
Summary (200 – 400 words)	Electromagnetic interference (EMI) is a major hurdle in systems ranging from electric vehicles (EVs) to advanced drones. Filtering inductors play a key role in suppressing EMI, but their parasitic properties complicate high-frequency performance, making early design and optimization challenging. This project leverages AI to optimize EMI filtering inductors by turning their characterization into a multi-objective problem, solving for all RLC parameters simultaneously. Students will use data-driven models and real-world inductor data to develop smarter design strategies. This project combines electromagnetics with artificial intelligence, addressing industry-critical needs in automotive, low-altitude airspace, and aerospace reliability. The **project scope** includes: (1) Review existing methods for inductor characterization and EMI mitigation; (2) Develop AI-based models for optimized filtering inductor design; (3) Validate methods with real measurement data, comparing performance. Students are expected to develop the following skills (**learning outcome**): (1) Understand the principles behind EMI filtering and inductor behavior; (2) Gain experience applying AI to multi-parameter engineering problems; (3) Validate and critically assess model performance on real datasets. The deliverable outcomes by the FYP students are: (1) Literature review on EMI filtering inductors and optimization techniques; (2) Two AI-driven modeling approaches (one by each student); (3) Comparative study of methods highlighting improvements over traditional approaches. **Prerequisite:** (1) Knowledge of basic circuit theory; (2) Familiarity with AI programming (Python/ML frameworks); (3) Interest in EMI suppression for EVs, drones, and high-reliability systems.
Student Workload Distribution	Student 1: Literature review, AI-based modeling and validation, comparative analysis with Student 2's approach.
	Student 2: Literature review, alternative AI-based modeling, validation, comparative analysis.
Supervisor	Zhao Zhenyu, zhaozy@nus.edu.sg
Laboratory Work	AI programming, electromagnetic interference analysis, inductor simulation.
No. of students	2
CA1 requirements	Literature review, problem framing, initial AI method design, early implementation.
CA2 requirements	Completed models with validation, final report, and presentation.

ID: SP55	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	3D-Printed ECG Electrodes for Physiologic Signal Monitoring
Summary (200 – 400 words)	Electrocardiogram (ECG) monitoring is essential for diagnosing cardiovascular diseases, with the increase of aging population. However, the conventional electrodes often cause skin irritation, discomfort, and signal degradation over time. Recent developments in additive manufacturing have enabled the implementation of low-cost 3D-printed electrodes that improve wearability and signal quality. These electrodes can be engineered for improved skin contact and long-term use, making them ideal for continuous physiologic monitoring. This project aims to design a portable ECG system using 3D-printed electrodes integrated with an Arduino-based signal acquisition module. A 3D printer will be adopted to design and fabricate ECG electrodes. The system will capture and process ECG signals, while at the same it can wirelessly communicate data to a smartphone for real-time analysis and visualization. By combining 3D printing for electrode fabrication and portable Arduino measurement system, this project seeks to enhance comfort, reduce costs, and improve accessibility to cardiac monitoring. The **project scope** includes: (1) Literature review of electrode technologies for ECG like physiological signals, portable measurement system and relevant technologies; (2) Design, fabrication and characterization of ECG electrodes using 3D printing technology; (3) Design, setup and testing of portable measurement system based on Arduino; (4) Integration of printed ECG electrodes and portable measurement system ECG measurement. Students are expected to develop the following skills (**learning outcome**): (1) To understand working principles of electronic device and ECG electrode sensors; (2) To be skilled on 3D printing technology for electrode fabrication; (3) To be skilled on embedded system development with wireless communication and basic mobile application development; (4) To be skilled on integration of electrode sensing technologies and portable measurement system. The deliverable outcomes by the FYP students are: (1) To design, fabricate and test functional ECG electrodes using 3D printer; (2) To build and test portable Arduino-based measurement system; (3) To measure ECG signals using the ECG electrodes and portable measurement system; (4) To improve the device and system design based on the testing. **Prerequisite:** Prior experience of software and hardware implementation is a must.
Student Workload Distribution	Student 1: on device/sensor, design, fabrication and characterization of ECG electrodes using 3D printing technologies.
	Student 2: on portable Arduino-based measurement system with communication between device and smartphone, data collection and analysis, and integration with ECG electrodes.
Supervisor	Zhu Chunxiang, E-mail: elezhucx@nus.edu.sg
Laboratory Work	Bench-top instruments, computer, 3D printer, impedance analyzer
No. of students	2
CA1 requirements	Design, fabricate and test of ECG electrodes based on 3D printer and portable measurement system. Simple demonstration.
CA2 requirements	Integration of ECG electrodes and portable measurement system for ECG signal detection.

ID: SP56	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Multi-Performer On-Stage Tracking Using RD-03D mmWave Radar for Live Production
Summary (200 – 400 words)	Modern live productions increasingly rely on real-time performer tracking to automate lighting cues, camera movements, and interactive effects. While optical systems are widely used, they are often limited by line-of-sight, lighting conditions, and the need for wearable markers. Millimeter-wave (mmWave) radar presents a compelling alternative, providing robust motion tracking in low-light and occluded environments. However, a key technical challenge remains: accurately distinguishing and tracking multiple performers simultaneously within the radar's field of view. This project aims to design and implement a multi-performer on-stage tracking system using mmWave radar sensors. The **project scope** includes: (1) Literature review on mmWave principles, point-cloud processing, and multi-target tracking algorithms (e.g., clustering, Kalman filtering, Hungarian assignment); (2) Hardware integration of the radar sensor with an embedded computing platform for data acquisition and preprocessing. (3) Software development of algorithms to identify and track multiple human targets within a dynamic stage environment. (4) Evaluation in simulated on-stage settings with varying numbers of performers and movement patterns. Students are expected to develop the following skills (**learning outcome**): (4) To be familiar with mmWave radar technology; (5) To be familiar with multi-target tracking; (6) To be familiar with hardware software integration for stage implementations; The deliverable outcomes by the FYP students are: (1) Prototype capable of tracking multiple performers with mmWave radar sensors. (2) Visualization dashboard displaying performer positions in real time. **Prerequisite:** Comfortable with ignal processing, Python/C++ programming, and basic networking protocols.
Student Workload Distribution	Student 1: mmWave sensor hardware and multi-target tracking algorithms
	Student 2: GUI development and multi-target tracking algorithms
Supervisor	Chua Dingjuan, elechuad@nus.edu.sg
Laboratory Work	Benchtop instruments for testing and measurements, Raspberry Pi
No. of students	2
CA1 requirements	Single-performer tracking prototype with basic visualization
CA2 requirements	Multi-performer tracking system with integrated GUI

ID: SP57	This FYP proposal is for 3+1+1 students at NUSRI Suzhou
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Development of a low-cost pico-satellite system
Summary (200 – 400 words)	The Satellite Technology and Research (STAR) centre has developed four 12U microsatellites - Lumelite-1 to Lumelite-4 satellites. The Lumelite-4 was launched in April 2023, with Lumelite-1 to Lumelite-3 will be launched by end of 2025. Currently, the STAR Centre is prioritizing on the development of low-cost pico-satellite system as part of its outreach to high school and undergraduate students, as well as its collaborations with local industry. The objective is to create an accessible, hands-on platform that supports space technology education and fosters industry engagement. This project aims to design and prototype a functional, low-cost pico-satellite system equipped with a Long Range (LoRa) ground station by utilizing the modular xChip platform from Maxiq Space. The xChip platform is a flexible and reconfigurable PCBs It contains components such as ESP32 microcontroller, an accelerometer, temperature sensor, wireless module, and a LoRa ground station. Students will select one or multiple payloads for integration, develop the necessary firmware for the pico-satellite system, and implement an MQTT server for real-time ground station communications. A custom 3D-printed structure will also be designed to house the xChip system and payloads. **The project scope includes:** **(1) Literature review of ESP32 microprocessor;** **(2) Literature review on LoRA ground station and MQTT server;** **(3) Study and select suitable payload(s) for project;** **(4) Integration of hardware and software to demonstrate the picosatellite operation.** Students are expected to develop the following skills (**learning outcome**): (1) To be familiar ESP32 microcontroller; (2) To be familiar with LoRA ground station; (3) To be skilled at microprocessor programming; (4) To understand the basic of satellite mission; The deliverable outcomes by the FYP students are: (1) Integrate payload(s) (camera by default) into the picosatellite system; (2) Required firmware for picosatellite system; (3) An MQTT server as part of LoRA ground station system; **Prerequisite:** Prior experience of software and hardware implementation is a must. C programming knowledge is required.
Student Workload Distribution	Student 1: on development of low-cost satellite firmware and payload. Student 2: on development of MQTT server and LoRA based ground station.
Supervisor	GOH Shu Ting, shuting@nus.edu.sg
Laboratory Work	Bench-top instruments, computer, 3D printer.
No. of students	2
CA1 requirements	Selection of Payload. Preliminary prototype with hardware and software development.
CA2 requirements	Demonstrate the integration of low-cost picosatellite system and telemetry downlink via LoRA ground station.

ID: SP58	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Design and Simulation of Neuromorphic Computing System based on RRAM for AI Applications
Summary (200 – 400 words)	Emerging non-volatile memory (NVM) devices show great potential in the next generation neuromorphic computing technology, which mitigates the large power consumption and latency induced by the "memory wall" in conventional Von-Neumann computer architecture. Among various emerging NVM devices, resistive random-access memory (RRAM) is well studied. In this project, the students are required to design and simulate an in-situ neuromorphic computing system based on RRAM crossbar array, and complete a simple supervised machine learning task with the system. The project scope includes: (1) Literature review of neuromorphic computing system based on emerging NVMs (2) To understand the device physics of RRAM and circuit arrays (3) To acquire some basic knowledge about machine learning and neural network (4) To design an in-situ neuromorphic computing system based on RRAM crossbar array in Simulink platform or in Verilog-A with the SPICE tools, or other software platform, including the crossbar array, control circuit, and the corresponding algorithm Through this project, students are expected to develop the following skills (learning outcome): (1) To understand the basic knowledge of the neuromorphic computing system based on emerging NVMs (2) To acquire the basic knowledge about machine learning and neural network (3) To be familiar with the basic circuit design (4) To write good technical reports and possibly submit papers to international conferences or journals The deliverable outcomes by the FYP students are: (1) To develop a circuit model for RRAM (2) To be familiar with Simulink platform or be skilled at Verilog-A programming in SPICE tools or other relevant software platform (3) To demonstrate a neuromorphic computing sub-system with a simple machine learning task by simulation (4) To analyse and benchmark the performance of the sub-system by simulation
Student Workload Distribution	Student 1: Develop a simple RRAM model for circuits simulation
	Student 2: To perform circuit and system design, including the crossbar array and the peripheral control circuits
Supervisor	Gong Xiao; elegong@nus.edu.sg
Laboratory Work	Matlab and Simulink, or Verilog-A and SPICE tools
No. of students	2
CA1 requirements	Develop the basics RRAM model and critical circuit components
CA2 requirements	Design neuromorphic computing system based on RRAM crossbar array

ID: SP59	This FYP proposal is for 3+1+1 students at NUSRI Suzhou
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Digital Bluetooth Stethoscope
Summary (200 – 400 words)	Stethoscope is a critical instrument for doctor for diagnosis. In this project, we will implement the digital bluetooth stethoscope that can mimic the mechanical stethoscope through microphone. At the same time, the sensed signal can be transmitted and displayed. The collected data can be further analysed using AI to aid the diagnosis. The **project scope** includes: (1) Literature review of stethoscope; (2) Design and implement the digital Bluetooth stethoscope; (3) Train the diagnosis using available stethoscope dataset; (4) Design user interface that is able to collect the data based on the developed stethoscope, and apply the AI analysis; Students are expected to develop the following skills (**learning outcome**): (1) To understand the stethoscope principle; (2) To develop the prototype; (3) To train AI model based on stethoscope dataset; (4) To implement GUI for the prototype with the aided diagnosis tool; The achievable outcomes by the FYP students are: (1) A completed prototype and software GUI; (2) Trained model with good diagnosis accuracy. **Prior experience of software and hardware implementation is a must.** If there are two students to work on the project, each student should carry out different design, and achieve the above-mentioned outcomes. **Prerequisite:** PCB design skill, embedded system development skill
Student Workload Distribution	Student 1: digital Bluetooth stethoscope prototype
	Student 2: train the AI model, develop GUI and incorporate the diagnosis tool
Supervisor	Heng Chun Huat, elehch@nus.edu.sg
Laboratory Work	PCB, soldering and hardware development
No. of students	2
CA1 requirements	Design the digital Bluetooth stethoscope prototype, train the AI model
CA2 requirements	Prototype demo, GUI development.

ID: SP60	This FYP proposal is for 3+1+1 students at NUSRI Suzhou
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Textile-Based Integrated Sensing Platforms for Next-Generation Human-Machine Interaction for metaverse applications
Summary (200 – 400 words)	Textile-based sensing platforms have become a research hotspot for building natural, continuous and multimodal human-computer interaction systems due to their natural advantages such as flexibility, breathability and wearability. This project aims to build an integrable and scalable textile-based multimodal sensing platform by integrating multiple sensing mechanism (e.g., pressure, stretch, EMG, temperature, IMU, etc.) into textile materials. This sensing platform is used to enhance the intelligence and naturalness of human-computer interaction systems, and is expected to realize high-precision real-time sensing of human body postures and movements, laying the foundation for the next-generation intelligent interaction systems aiming at metaverse applications. The **project scope** includes: (1) Literature review on the design of textile-based sensing devices and related technologies; (2) Design textile-based multimodal sensors for stable embedding and modular layout of sensors in textile materials through innovative structural integration approaches; (3) Construction of a real-time signal acquisition and fusion system, combined with machine learning algorithms to enhance interaction recognition accuracy and robustness; (4) Multi-modal Machine learning enabled sensory data analytics of the performance and applications. (5)Demonstration of VR related metaverse applications Students are expected to develop the following skills (**learning outcome**): (60) To understand flexible electronic device design process; (61) To be familiar with embedded systems and hardware integration; (62) To be skilled at microprocessor programming; (63) To be skilled at the design and application implementation of human-computer interaction systems; The deliverable outcomes by the FYP students are: (1) To construct wearable textile-based multimodal sensor devices; (2) To design a complete data acquisition and processing software module; (3) To realize the acquisition, fusion and recognition of multi-channel sensing signals; (4) To apply machine-learning approaches to analyse the multi-modal sensory data; (5) To demonstrate the functionality of a complete HMI-oriented scenarios in metaverse. **Prerequisite:** Prior experience of software and hardware implementation is a must.
Student Workload Distribution	Student 1: development of sensors, sensing platform construction, including electrode networks, sensor networks, and microcontrollers; VR applications
	Student 2: on communication between sensor devices and computers, data collection and analysis, and algorithm design; multimodal machine learning
Supervisor	Chengkuo Lee; elelc@nus.edu.sg
Laboratory Work	Bench-top instruments, computer, 3D printer.
No. of students	2
CA1 requirements	Prototype construction of textile-based sensors, basic data acquisition and presentation.
CA2 requirements	Complete wearable interaction system with multimodal sensing, data processing and machine learning data analytics; demonstration of metaverse applications

ID: SP61	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Title of Project	Passive radar with the ADALM-PLUTO software defined radio
Summary (200 – 400 words)	The objective of the project is to develop a passive radar with the ADALM-PLUTO software defined radio The ADALM-PLUTO is a software defined radio that can transmit and receive signals over a wide frequency range. In this project, the ADALM-PLUTO is used to research and develop a passive radar. The **project scope** includes: (1) Literature review of radar principles, including the Doppler effect; (2) Review of the ADALM-PLUTO; (3) Modification of the ADALM-PLUTO to add the internal channel; (4) Selection of receiver antennas; (5) Development and demonstration the passive radar. Students are expected to develop the following skills (**learning outcome**): (64) To understand radar scattering mechanisms and the Doppler effect; (65) To understand the functional behavior of the ADALM-PLUTO; (66) To apply (Doppler) radar signal processing; (67) To develop the passive radar; (68) To acquire the passive radar signals and apply signal processing. The achievable outcomes by the FYP students are: (1) Development of the passive radar concept, including the ADALM-PLUTO code; (2) Fabricated and tested passive radar, including antennas; (3) Possibly a conference contribution. . This project requires two students who are keen to work together on the development of passive radar using the ADALM-PLUTO.
Student Workload Distribution	Student 1: Develop the passive radar hardware, including the antennas and the modification of the ADALM-PLUTO.
	Student 2: Develop the necessary software in the ADALM-PLUTO
Supervisor	Koen Mouthaan k.mouthaan@nus.edu.sg
Laboratory Work	Bench-top instruments
N0. of students	2
CA1 requirement	Literature review, familiarization with passive radar, testing of the ADALM-PLUTO;
CA2 requirement	Development of the passive radar using the ADALM-PLUTO.

ID: SP62	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	GaN AC/DC Rectifier for EV Charging
Summary (200 – 400 words)	Wide band gap (WBG) semiconductor devices are the future of high-density high-efficiency low cost and light wright power electronics. This project aims to analyse and design a compact GaN semiconductor based single-phase EV charger through controlled AC/DC rectifier. The project includes mathematical analysis, implementation of modulation strategy, design of components, simulation, and hardware development and testing. The **project scope** includes: (1) Literature review of GaN-based AC/DC controlled rectifier topologies and modulation techniques (2) Differences in design of Si and GaN based controlled rectifiers (AC/DC converters) (3) High-temperature and high-switching frequency design study (4) Simulation of the rectifier with GaN parasitic (5) Hardware development, testing, and demonstration with unity power factor operation Students are expected to develop the following skills (**learning outcome**): (1) To understand GaN semiconductor device characteristics and operation (2) To be familiar with circuit analysis and programming (3) To be skilled at thermal and high-frequency analysis and design (4) To be skilled at hardware design, development and testing The deliverable outcomes by the FYP students are: (1) To demonstrate learning of thermal design and management as well as high-switching frequency operation of the GaN devices (2) To improve and demonstrate the density, cost, and weight of the converter (3) To enhance the gate driver and operation learning and training at high device switching frequency of GaN devices **Prerequisite:** Prior experience of hardware implementation is required.
Student Workload Distribution	Student 1: on circuit hardware development, thermal analysis, and design with GaN semiconductor devices.
	Student 2: on simulation, modulation implementation through programming, gate driver development. Testing, calculation, and benchmarking will be done together
Supervisor	Akshay Kumar Rathore, akshay.rathore@nus.edu.sg
Laboratory Work	Bench-top instruments, computer, power supplies, logic power supply, meters and scope
No. of students	2
CA1 requirements	Mathematical analysis, circuit design, thermal design, and simulation results
CA2 requirements	Preliminary prototype with hardware and software development. Simple demonstration.

ID: SP63	This FYP proposal is for 3+1+1 students at NUSRI Suzhou
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Real-time Freezing of Gait Detection and Biofeedback for Parkinson Diseases
Summary (200 – 400 words)	In this project, our objective is to make use of machine learning algorithms to detect the freezing of gait (FOG) in Parkinson's Disease (PD) patients. FOG is a sudden and episodic inability to generate effective stepping among PD patients. It poses a risk for falls and deteriorates a patient's quality of life. We have data of PD patients gait patterns, the objective here is to make use of machine learning algorithms to predicts these FOG episodes. The **project scope** includes: (1) Literature review of machine learning algorithms; (2) Literature review of Freezing of Gait; (3) Development of wearable sensors for measuring gait. (4) Implementation of FOG algorithms. Students are expected to develop the following skills (**learning outcome**): (1) To understand basic knowledge of Telehealth and its key components; (2) To be skilled at embedded system, Arduino/Raspberry Pi; IMUs; (3) To be skilled BLE communication and App development; (4) To be skilled in machine learning algorithms; (5) To be skilled Webapp development. The achievable outcomes by the FYP students are: Development of a mobile vital signs monitoring system. This project can take up to 2 students: Both students will work on the initial FoG detection using Machine learning. Student 1: Implementation of biofeedback system. Student 2: Implementation of machine learning algorithms in hardware. **Prerequisite: Must have some experiences in embedded systems, comfortable with programming**
Student Workload Distribution	Student 1: Both students will work on the initial FoG detection using Machine learning. Student 1: Implementation of biofeedback system. Student 2: Implementation of machine learning algorithms in hardware.
Supervisor	Arthur Tay, eletaya@nus.edu.sg
Laboratory Work	Computer
No. of students	2
CA1 requirements	Literature review and software platform/hardware. Develop algorithm.
CA2 requirements	Development of biofeedback fog detection.

ID: SP64	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Real-Time Texture Recognition Using Machine and Deep Learning for Camera-Based Applications
Summary (200 – 400 words)	This is a state-of-the-art project in AI-assisted texture recognition. Texture recognition is a core problem in computer vision with applications in materials science, chip design, medical imaging, industrial inspection, and remote sensing. The goal is to evaluate and enhance classical machine learning and modern deep learning models for this task using benchmark texture datasets. In semiconductor industry, it enables automated detection of surface defects, irregularities, and process anomalies during wafer inspection and device fabrication, which is critical for quality control and yield improvement. Both ML and DL based methods can be explored. This includes, feature extractors, use of classifiers, PCA analysis, CNNs and its variants, transfer learning, etc. There is a good amount of datasets available to test the methods. Key research challenges include, studying intra and inter class variations and similarity, etc. Project can attempt to propose hybrid techniques using either ML-focused or DL-focused models. We can assume two different applications and explore the methods. All methods to be evaluated using a set of metrics including, accuracy, F1-score, confusion matrices, robustness to noise, etc. Each student will implement a base method and a hybrid strategy to compare the results. The ***project scope*** includes: 1. Literature review of texture recognition methods; 2. Use of Machine learning tools to implement the methods; 3. To evaluate the performance of the methods and perform a comparative study. Students are expected to develop the following skills ***(learning outcome***): 1. To understand basic knowledge of texture recognition methods 2. To evaluate a given ML/DL method and to use appropriate metrics indicated The ***achievable outcome*** by the FYP students for the CA assessment are: 1. To identify and implement MD method using the methods specified above; signal 2. Performance Evaluation - influencing parameters; accuracy of prediction. 3. To use any hybrid techniques to cross-validate the earlier methods. **Expected Pre-req Skills** – Python related Python packages/Machine learning packages; must be able to interpret and analyse data. If there are two students to work on the project, each student should carry out two different methods for a given dataset and perform all-to-all comparison.
Student Workload Distribution	Student 1: A base model and an algorithm – joint effort, one individual learning model and implementation, compare with Student 2; Can try any novel hybrid method;
	Student 2: A base model and algorithm – joint effort, one individual learning model and implementation, compare with Student 1; Can try any novel hybrid method;
Supervisor	A/Prof Bharadwaj Veeravalli, elebv@nus.edu.sg
Laboratory Work	Software/Laptop/ ML/DL Python related packages
No. of students	2
CA1 requirements	Project scope (1) and (2); Students must be familiarize themselves on the existing algorithms/methods; Relevant programming tools must be learnt and must demonstrate small scale relevant examples
CA2 requirements	To implement and evaluate the performance of hybrid/novel ML based methods – demonstration of a full-fledged simulation with relevant dataset.

ID: SP65	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	High-precision pressure sensing for safer, smarter toothbrushing
Summary (200 – 400 words)	Electric toothbrushes often include force sensing features to prevent excessive brushing pressure, which can cause gum damage or enamel erosion. However, commercial implementations of force sensing are often unreliable or limited in sensitivity, response time, or cost-effectiveness. In many cases, force feedback is indirect or inaccurate, relying on motor current changes or mechanical deformation that may not correlate well with actual brushing force. This project aims to investigate the limitations of force sensing in current electric toothbrushes through measurement and analysis, and to develop and evaluate alternative sensing techniques that provide more accurate, real-time force feedback. The project will involve two students and consists of: analysis of current commercial solutions through teardown, sensor characterization, and data collection and exploration, prototyping, and evaluation of alternative force sensing methods, including novel sensor integration and signal processing. The **project scope** includes: 1) Review existing force sensing methods in electric toothbrushes through literature and product teardown; identify current limitations such as accuracy, latency, and user variability. 2) Measure and analyze brushing force using various sensing approaches under different conditions; define performance requirements for improvement. 3) Explore and prototype alternative force sensing techniques (e.g., capacitive, piezoelectric, optical, magnetic) for better accuracy and responsiveness. 4) Develop and evaluate basic signal processing or ML models to interpret sensor data; benchmark prototypes against commercial sensors in terms of performance, cost, and usability. Students are expected to develop the following skills (**learning outcome**): 1) Understand limitations of current force sensing methods in consumer devices. 2) Learn techniques for sensor testing, calibration, and benchmarking. 3) Gain hands-on experience with alternative force sensing technologies. 4) Develop skills in basic electronics, prototyping, and signal analysis. 5) Apply data-driven design to propose feasible improvements for real-world products. The deliverable outcomes by the FYP students are: 1) Detailed analysis and documentation of force sensing mechanisms used in current commercial electric toothbrushes. 2) Measurement data and performance evaluation of existing sensing methods under various brushing conditions. 3) Prototypes of alternative force sensing techniques with improved accuracy, sensitivity, and response time. 4) Signal processing or machine learning models to interpret brushing force data in real time. **Prerequisite:** Prior experience of hardware and software implementation is a must.
Student Workload Distribution	Student 1: Perform teardown and analysis of commercial electric toothbrushes; measure and evaluate existing force sensing methods; support data collection and documentation.
	Student 2: Explore and prototype alternative sensing techniques; develop signal processing or ML models for interpreting sensor data; assist with evaluation and final reporting.
Supervisor	Wu Yihong; email: elewuyh@nus.edu.sg
Laboratory Work	Bench-top instruments, electronic components, force sensor, computer
No. of students	2
CA1 requirements	Literature review, commercial product analysis, preliminary data collection, and proposal of feasible alternative sensing concepts.
CA2 requirements	Prototype development, performance evaluation, algorithm testing, and comparison with commercial toothbrush force sensing systems.

ID: SP66	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	AI-Enhanced Smart Travel Planning Agent for Small Group Itinerary Generation
Summary (200 – 400 words)	Planning trips for individuals or small groups is often complex due to varying preferences, budgets, and purposes. This project proposes the development of an AI-powered Smart Travel Planning Agent that leverages generative AI tools such as ChatGPT and DeepSeek to automate and personalize travel planning for 1 to 6 individuals. The system will take user inputs including travel dates, budgets, interests (e.g., food, nature, culture), and the trip's purpose (e.g., business, leisure). It will then generate traceable daily itineraries tailored to the group, supporting both shared and individualized plans. The system enables interactive refinement via a chat interface where users can modify suggestions and receive updated plans instantly. AI-driven suggestions will be explainable with visible logic, sources, and constraints. The **project scope** includes: (1) Design of a group profile builder to gather preferences for multiple users; (2) Backend integration with generative AI and travel APIs (ChatGPT, DeepSeek, Google Places); (3) Development of a group-aware recommendation engine and itinerary generator; (4) Creation of an interactive chat-based user interface for refinement; (5) Visualization of itineraries and logging of AI logic and sources for transparency. Students are expected to develop the following skills (**learning outcome**): (1) To understand integration and orchestration of generative AI tools in application design; (2) To be able to develop user-aware recommendation logic for multi-user inputs; (3) To be able to design full-stack web applications with strong usability focus; (4) To be able to implement responsible AI design with logging and explanation mechanisms; (5) To be able to manage real-world edge cases (e.g., partial participants, budget constraints). The deliverable outcomes by the FYP students are: (1) Interactive web application for group travel planning (1–6 users); (2) Group-adaptive daily travel itineraries; (3) Transparent AI-driven recommendations with logic traceability; (4) Chat-based interface for live itinerary refinement; (5) Final report, demo, and technical documentation. **Prerequisite:** Basic experience in full-stack development, API usage, and Python programming. Prior exposure to NLP or LLMs is beneficial.
Student Workload Distribution	Student 1: Development of group-profile input interface and backend itinerary generation logic.
	Student 2: AI integration with ChatGPT/DeepSeek APIs, refinement module, and itinerary traceability.
Supervisor	Zhang Jianwen, elezhan@nus.edu.sg
Laboratory Work	Laptops/desktops with development environments (Python, Streamlit/React)
No. of students	2
CA1 requirements	Prototype web interface for collecting group preferences and generating an initial AI-based itinerary for a 3–5 day trip.
CA2 requirements	Full system including itinerary generation, chat-based refinement, visualization, and source explanation. Demo with sample group input and output.

ID: SP67	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	MEMS-Based Monitoring System for Physiological and Motion Sensing
Summary (200 – 400 words)	Microelectromechanical systems (MEMS) have been developed in making various sensors. Accelerometers and gyroscopes are two major MEMS sensors that have been widely used. Recent advancements have witnessed their use in wearable health monitoring by enabling compact, low-power, and high-precision motion and physiological signal detection. Combining the motion detection with physiological signal monitoring, it can provide a more comprehensive health analysis, particularly for mobility-related scenarios. This project aims to develop an integrated system using MEMS accelerometers and gyroscopes to detect both motion and physiological signals such as heart rate and respiratory rate. The system will leverage Arduino for data acquisition and processing, including wireless connection to a smartphone for real-time visualization. By merging motion and physiological signals, this approach could enhance applications in remote patient monitoring, sports science, and rehabilitation. The **project scope** includes: (1) Literature review of MEMS accelerometer and gyroscope for physiological signals and motion detection, portable measurement system and relevant technologies; (2) Design, setup and test of accelerometer and gyroscopes for motion and physiological signals sensing; (3) Design, setup and test of portable measurement system based on Arduino; (4) Integration of MEMS accelerometer/gyroscope, portable measurement system, and wireless communication for motion and physiological signals detection. Students are expected to develop the following skills (**learning outcome**): (1) To understand working principles of electronic device and MEMS sensors; (2) To be skilled on MEMS sensor integration and signal conditioning for biomedical applications; (3) To be skilled on embedded system development with wireless communication and basic mobile application development; (4) To be skilled on integration of MEMS sensors and portable measurement system. The deliverable outcomes by the FYP students are: (1) To design and test MEMS sensors integration and signal conditions; (2) To build and test portable Arduino-based measurement system; (3) To measure motion and physiological signals using the MEMS sensors and portable measurement system; (4) To improve the sensing system design based on the testing. **Prerequisite:** Prior experience of software and hardware implementation is a must.
Student Workload Distribution	Student 1: on device/sensor, design, setup and test of MEMS sensors for motion and physiological signals.
	Student 2: on portable Arduino-based measurement system with communication between device and smartphone, data collection and analysis, and integration with MEMS sensors.
Supervisor	Zhu Chunxiang, E-mail: elezhucx@nus.edu.sg
Laboratory Work	Bench-top instruments, computer.
No. of students	2
CA1 requirements	Design, setup and test of the functions of MEMS sensors and portable measurement system. Simple demonstration.
CA2 requirements	Integration of MEMS sensors and portable measurement system for motion and physiological signal detection.

ID: SP68	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Development of 2D beam-map for antenna array based multi-target tracking
Summary (200 – 400 words)	The Satellite Technology and Research Centre has developed three 18 kg microsatellites, Lumelite-1 to Lumelite-3, scheduled for launch in late 2025. However, limited availability of ground stations in Singapore, mainly due to restricted land space and signal obstruction from high-rise buildings are the primary challenges for Lumelite-1 to Lumelite-3 operation. Therefore, there is a strong need for a antenna array-based mobile ground station solution, which can be rapidly deployed and reconfigured. Antenna arrays offer the capability to actively and simultaneously track multiple satellites using adaptive beamforming techniques. However, sidelobes in the antenna radiation pattern can cause interference, potentially disrupting communication between non-target satellites and other ground stations. Therefore, it is essential for the antenna array system to minimize sidelobe gain while maintaining high-gain beams toward target satellites. This project aims to develop a software tool for generating 2D beam-map datasets. The dataset will be used to train the machine learning algorithm developed under STAR centre for antenna array-based multi-target tracking. The software will include a filtering mechanism to ensure that only configurations with low sidelobe gain are selected for the dataset. The resulting 2D beam-maps will provide comprehensive coverage for both single-target and multi-target tracking scenarios. **The project scope includes:** **(1) Literature review of antenna array beamforming theory;** **(2) Develop a software tool to provide 2D beam-map and corresponding antenna array configuration data, and** **(3) Develop a software tool to filter high sidelobe gain from the 2D beam-map dataset.** Students are expected to develop the following skills (**learning outcome**): (1) To understand the impact of phase and gain on antenna array beam pattern; (2) To be familiar with the digital beamforming techniques; (3) To understand the electronic components in antenna array elements, and (4) To be skilled at matlab/python programming. The deliverable outcomes by the FYP students are: (1) A software tool capable of generating required beam and null pattern dataset; (2) A software tool that converts beam pattern information into 2D beam-map, and (3) A software tool that filters undesired beam pattern dataset. **Prerequisite:** Either python or Matlab knowledge is a must.
Student Workload Distribution	Student 1: on development of beam pattern and 2D beam map generation software. Student 2: on development of undesired beam pattern dataset filtering software.
Supervisor	GOH Shu Ting, shuting@nus.edu.sg
Laboratory Work	Computer
No. of students	2
CA1 requirements	Presentation of beam pattern dataset for antenna array size of 16 x 16 (or lesser). Demonstrate the capability to filter high sidelobe gain from dataset.
CA2 requirements	Presentation of beam pattern dataset for simultaneous multi-target tracking (2 or 3) scenario. Demonstrate only low sidelobe gain beam patterns are included.

ID: SP69	This FYP proposal is for 3+1+1 students at NUSRI Suzhou
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Permittivity measurement equipment
Summary (200 – 400 words)	In this project, we will develop permittivity measurement equipment based on capacitance principle. We will develop a VCO which frequency is dependent on the capacitance. As the capacitance can vary depending on the permittivity of the material, this provides us a mean to measure the permittivity by measuring the VCO frequency. The **project scope** includes: (1) Literature review of permittivity measurement; (2) Design VCO with capacitive sensor; (3) Evaluate the performance of the resulting permittivity measurement instrument; Students are expected to develop the following skills (**learning outcome**): (1) To understand the permittivity measurement principle; (2) To develop the prototype for the equipment through PCB design; (3) To evaluate the performance; The achievable outcomes by the FYP students are: (1) A completed prototype; (2) Measurement on various material with different permittivities.. **Prior experience of software and hardware implementation is a must.** If there are two students to work on the project, each student should carry out different part of the design, and achieve the above-mentioned outcomes. **Prerequisite:** PCB design skill, embedded system development skill
Student Workload Distribution	Student 1: Work on the VCO prototype with capacitive sensor
	Student 2: Custom-made the capacitive sensor and software GUI
Supervisor	Heng Chun Huat, elehch@nus.edu.sg
Laboratory Work	Not applicable
No. of students	2
CA1 requirements	Review of permittivity measurement technique and design of VCO as well as capacitive sensor
CA2 requirements	Prototyping and measurement on various material, characterizing its sensitivity and limitation.

ID: SP70	**This FYP proposal is for 3+1+1 students at NUSRI Chongqing**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Design of Mid Infrared / Terahertz Metasurface Based on Large Language Model
Summary (200 – 400 words)	This project focuses on the development of advanced metasurfaces operating in the mid-infrared (MIR) and terahertz (THz) spectral regimes, with the goal of exploring large language model (LLM)-assisted design methodologies. Conventional metasurface development often involves time-consuming manual parameter sweeps and requires substantial domain expertise. These limitations become particularly evident when dealing with different electromagnetic regimes such as MIR and THz, which demand distinct material choices, resonance mechanisms, and structural considerations. To overcome these challenges, this project integrates large language models into the design pipeline to accelerate innovation and foster generalizable design strategies. The MIR-focused track will address applications such as molecular fingerprinting, thermal imaging, and environmental sensing, while the THz-focused track will explore functionalities relevant to security screening, high-speed communication, and non-destructive testing. This project will investigate frequency-selective surface concepts, utilize multi-physics simulation platforms (e.g., FDTD, FEM), and adopt LLM-assisted inverse design techniques to propose and refine metasurface geometries. In addition to guiding structural proposals, the LLMs will assist in interpreting simulation results, suggesting optimization directions, and generalizing across device families. The **project scope** includes: (1) Literature review on MIR and THz metasurfaces and related applications; (2) Simulation and design of MIR and THz metasurfaces using tools such as FDTD or FEM; (3) Use of large language models (LLMs) to assist in structure generation, result analysis, and design optimization; (4) Validation and comparison of device performance and LLM-assisted design workflow. Students are expected to develop the following skills (**learning outcome**): (69) To understand the basic principles of MIR and THz metasurfaces; (70) To use simulation tools such as FDTD and COMSOL effectively; (71) To apply LLMs in design generation, optimization, and result interpretation; (72) To design and evaluate a metasurface device in the MIR or THz range; The deliverable outcomes by the FYP students are: (1) To complete literature review and technical understanding of MIR and THz metasurfaces; (2) To design and simulate one MIR metasurface device and one THz metasurface device using electromagnetic tools; (3) To apply LLMs in the metasurface design workflow, including geometry generation and optimization guidance; (4) To virtually validate the proposed designs and evaluate their electromagnetic performance; **Prerequisite:** To have basic knowledge of electromagnetics and experience with simulation tools. Familiarity with AI tools is a plus.
Student Workload Distribution	Student 1: on MIR metasurface design, including simulations and using LLMs for geometry creation, result analysis, and optimization.
	Student 2: on THz metasurface design, performing simulations and applying LLMs for inverse design, parameter tuning, and interpretation.
Supervisor	Chengkuo Lee, elelc@nus.edu.sg
Laboratory Work	Lumerical-FDTD, COMSOL, large language models, python
No. of students	2

CA1 requirements	Literature review of MIR and THz metasurfaces and basic study of their electromagnetic properties using simulation tools. Preliminary designs of MIR and THz metasurfaces with initial LLM-assisted geometry proposals and simulation verification.
CA2 requirements	Advanced design, optimization, and validation of MIR and THz metasurfaces using LLM-guided inverse design methods. Complete simulation analysis, performance evaluation, and demonstration of LLM-driven design effectiveness in both spectral regimes.

ID: SP71	**This FYP proposal is for 3+1+1 students at NUSRI Chongqing**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Title of Project	Spectrum monitoring with the ADALM-PLUTO software defined radio
Summary (200 – 400 words)	The objective of the project is to develop a radio spectrum monitoring system with the ADALM-PLUTO The ADALM-PLUTO is a software defined radio that can transmit and receive signals over a wide frequency range. In this project, the ADALM-PLUTO is used to research and develop a spectrum monitoring system. In particular, the spectrum monitor system should be able to steer a receiving beam to a signal of interest. The **project scope** includes: (1) Literature review of spectrum monitoring systems; (2) Review of the ADALM-PLUTO; (3) Modification of the ADALM-PLUTO to add the internal receiver channel; (4) Selection of receiver antennas; (5) Development and demonstration the spectrum monitoring system. Students are expected to develop the following skills (**learning outcome**): (73) To understand the radio spectrum and the signals present in the spectrum; (74) To understand the functional behavior of the ADALM-PLUTO; (75) To apply signal processing; (76) To develop the spectrum monitor; (77) To acquire the spectrum signals and apply signal processing. The achievable outcomes by the FYP students are: (1) Development of the spectrum monitor, including the ADALM-PLUTO code; (2) Fabricated and tested spectrum monitor, including antennas; This project requires two students who are keen to work together on the development of a spectrum monitor the ADALM-PLUTO.
Student Workload Distribution	Student 1: Develop the hardware, including the antennas and the modification of the ADALM-PLUTO.
	Student 2: Develop the necessary software in the ADALM-PLUTO, including the direction of arrival estimation.
Supervisor	Koen Mouthaan k.mouthaan@nus.edu.sg
Laboratory Work	Bench-top instruments
N0. of students	2
CA1 requirement	Literature review, familiarization with spectrum monitoring, testing of the ADALM-PLUTO;
CA2 requirement	Development of the passive spectrum monitor, including direction of arrival estimation, using the ADALM-PLUTO.

ID: SP72	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Freezing of Gait Prediction for Parkinson Diseases
Summary (200 – 400 words)	In this project, our objective is to investigate various machine learning algorithms to predict the freezing of gait (FOG) in Parkinson's Disease (PD) patients. FOG is a sudden and episodic inability to generate effective stepping among PD patients. It poses a risk for falls and deteriorates a patient's quality of life. We have data of PD patients gait patterns, the objective here is to make use of machine learning algorithms to predicts these FOG episodes. The **project scope** includes: (1) Literature review of deep/machine learning algorithms; (2) Literature review of Freezing of Gait; Students are expected to develop the following skills (**learning outcome**): (1) To understand basic knowledge of Telehealth and its key components; (2) To be skilled in machine learning algorithms; The achievable outcomes by the FYP students are: Development of a mobile vital signs monitoring system. This project can take up to 2 students: Both students will work on the initial deep learning framework and public database. Student 1: focus on the issue of prediction duration. Student 2: focus on the issue of window size. **Prerequisite: Must be good in mathematics and comfortable with programming**
Student Workload Distribution	Student 1: Both students will work on the initial deep learning framework and public database. Student 1: focus on the issue of prediction duration.
	Student 2: focus on the issue of window size. Comparing across various dataset.
Supervisor	Arthur Tay, eletaya@nus.edu.sg
Laboratory Work	Computer
No. of students	2
CA1 requirements	Literature review and software platform. Develop algorithm.
CA2 requirements	Development of fog prediction.

ID: SP73	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	ML/DL-assisted Approaches for Fault Detection in Semiconductor Manufacturing
Summary (200 – 400 words)	This is a state-of-the-art project in semiconductor manufacturing domain. Semiconductor fabrication involves complex, multi-step processes where faults (defects, anomalies) can lead to massive yield losses. This project aims to use machine learning (ML) and deep learning (DL) to detect such faults early using sensor, wafer map, and/or image data. We will explore both ML and DL methods. Since the faults can arise at different stages aiming at a reliable dataset is important. We will attempt to use UCI ML repository and other wafer map datasets for our study. We can also explore other datasets available in China market. Key challenges include, handling imbalanced data, high dimensional data, handling rare or emerging or unknown faults, etc. This latter issue needs anomaly detection. We can attempt to devise hybrid strategies and all methods need to be evaluated using a set of metrics including, accuracy, F1-score, confusion matrices, robustness to noise, etc. Each student will implement a base method and a hybrid strategy to compare the results. The ***project scope*** includes: 1) Literature review of semicon manufacturing and fault detection methods; 2) Use of Machine learning tools to implement the methods; 3) To evaluate the performance of the methods and perform a comparative study. Students are expected to develop the following skills ***(learning outcome***): 1) To understand basic knowledge of fault detection methods 2) To evaluate a given ML/DL method and to use appropriate metrics indicated The ***achievable outcome*** by the FYP students for the CA assessment are: 1) To identify and implement ML/DL methods 2) Performance Evaluation - influencing parameters; accuracy of prediction, etc 3) To use any hybrid techniques to cross-validate the earlier methods. **Expected Pre-req Skills** – Python related Python packages/Machine learning packages; must be able to interpret and analyse data. If there are two students to work on the project, each student should carry out two different methods for a given dataset and perform all-to-all comparison.
Student Workload Distribution	Student 1: A base model and an algorithm – joint effort, one individual learning model and implementation, compare with Student 2; Can try any novel hybrid method;
	Student 2: A base model and algorithm – joint effort, one individual learning model and implementation, compare with Student 1; Can try any novel hybrid method;
Supervisor	A/Prof Bharadwaj Veeravalli, elebv@nus.edu.sg
Laboratory Work	Software/Laptop/ ML/DL Python related packages
No. of students	2
CA1 requirements	Project scope (1) and (2); Students must be familiarize themselves on the existing algorithms/methods; Relevant programming tools must be learnt and must demonstrate small scale relevant examples
CA2 requirements	To implement and evaluate the performance of hybrid/novel ML based methods – demonstration of a full-fledged simulation with relevant dataset.

ID: SP74	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Magnetic tracking using smartphone and standalone magnetic sensors
Summary (200 – 400 words)	Magnetic tracking has applications in many areas such as robotics, augmented reality, machine assisted surgery, location detection, 3D positioning, cargo tracking, etc. A typical magnetic tracking system consists of one or more magnetic sensors and magnetic field generators. The latter can be the geomagnetic field or field generated by magnets, current coils, etc. During the operation, either the magnet or sensor will be moved around and their relative locations will be determined from the field detected in three orthogonal directions. A major advantage of magnetic tracking is that it does not require a line-of-sight between transmitter and receiver because magnetic fields can penetrate through many materials such as wall, wood, plastic, ceramic, rubber, human body, etc. In addition, there is also no need to power the permanent magnets when they are used as the field generator. In this project, a two-student team will develop a 3D magnetic tracking system to track a moving permanent magnet using either standalone magnetic sensors or built-in magnetometer in a smartphone and explore potential applications. The **project scope** includes: 1) Review electromagnetic tracking techniques, focusing on systems using permanent magnets. 2) Design system layout and source components for building a tracker using standalone magnetic sensors. 3) Develop software to access and process data from smartphone built-in magnetometers and implement 3D field calculations using the dipole model. 4) Build, test, and evaluate the complete tracking systems, and demonstrate potential applications such as pen motion tracking. Students are expected to develop the following skills (**learning outcome**): 1) Understand the working principle of a wide range of magnetic sensors and their applications in magnetic tracking. 2) Design and implement an intelligent sensing system from devices to system that both cover hardware and software design and engineering integration. 3) Design and develop smartphone-based APPs. 4) Be familiar with translational research and development. The deliverable outcomes by the FYP students are: 1) A functional 3D magnetic tracking system. 2) Software or algorithm to compute 3D position from magnetic field measurements. 3) Evaluation and testing results demonstrating tracking accuracy, range, and robustness. 4) Exploration and demonstration of at least one potential application. 5) Final project report documenting system design, implementation, and key results. 6) **Prerequisite:** Prior experience of hardware and software implementation is a must.
Student Workload Distribution	Student 1: Design and build the tracking system using standalone sensors; source components, test hardware, and support system evaluation and demo.
	Student 2: Develop software for smartphone magnetometer data access and 3D tracking using the dipole model; process data and assist with testing and demo.
Supervisor	Wu Yihong; email: elewuyh@nus.edu.sg
Laboratory Work	Bench-top instruments, electronic components, magnetic sensors, computer
No. of students	2
CA1 requirements	Prepare technical specs and block diagram, design and build sensing circuits, and develop hardware/software for signal processing and demonstrate a working smartphone app.
CA2 requirements	Testing, evaluation and improvement of the tracking system; demonstration of accurate tracking of moving magnet with potential applications.

ID: SP75	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Modeling and Simulation of OECTs for Biosensors and Logic Circuits
Summary (200 – 400 words)	Organic Electrochemical Transistors (OECTs) have emerged as a new technology in bioelectronics due to their unique ability in offering low-voltage operation, high sensitivity, and compatibility with flexible substrates. OECTs leverage mixed ionic-electronic conduction in organic semiconductors, making them ideal for biosensing applications such as glucose monitoring, neural recording, and DNA detection. Beyond sensing, their tunable electrochemical properties enable novel applications in low-power logic circuits and neuromorphic computing. However, the widespread adoption of OECTs requires accurate device models to predict performance and optimize circuit design, which remains a challenge. This project aims to simulate OECT devices by using TCAD software and to develop a SPICE-compatible model for OECTs. By combining device physics with circuit simulation tools, we aim to create a framework for designing OECT-based biosensors and logic circuits. The project will explore transient response, threshold voltage, and ion transport dynamics to study how various factors influence the circuit performance. Such models are critical for accelerating the development of OECT-based systems, from wearable health monitors to biodegradable electronics. The **project scope** includes: (1) Literature review of OECT devices and circuits, especially on modelling and simulation of the devices; (2) Work on TCAD-based device simulation for OECT and develop understanding on device physics; (3) Develop SPICE like device model for OECT devices; (4) Simulate OECT-based circuits, including biosensor readouts and logic gates. Students are expected to develop the following skills (**learning outcome**): (1) To understand working principles and device physics of electronic/ionic device OECT; (2) To be skilled on TCAD device simulation; (3) To be skilled on SPICE like device model for devices; (4) To be skilled on circuit simulation on OECT-based on biosensor readouts and digital circuits. The deliverable outcomes by the FYP students are: (1) To simulate OECT device by using TCAD software; (2) To develop SPICE like device model for OECT; (3) To simulate OECT-based biosensor and digital circuits; (4) To improve the device modelling and circuit simulation results based on the comparison with experimental results. **Prerequisite:** Prior knowledge on semiconductor and device physics is a must.
Student Workload Distribution	Student 1: on TCAD simulation of OECT as well as to understand the influences of various parameters on device performance.
	Student 2: on circuit simulation, including SPICE like model development for OECT and OECT-based circuit simulation.
Supervisor	Zhu Chunxiang, E-mail: elezhucx@nus.edu.sg
Laboratory Work	Computer
No. of students	2
CA1 requirements	Design, simulation, and understanding of OECT based on TCAD software. SPICE like device model for OECT.
CA2 requirements	Simulate and understand the influences of various design parameters on OECT performance. OECT-based circuit simulation for biosensor and digital circuit.

ID: SP76	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	A software for enhancing python programming learning experience
Summary (200 – 400 words)	To enhance student in learning python programming experience, particular in image processing, object detection and classification, multiple visual script tool related development projects were introduced via NUS undergraduate research opportunities programme (UROP). Each UROP student is responsible to develop the visual script tool on given python packages. The projects were completed in summer 2025. The visual script tool allows user to use coding block to represent each python function without explicitly writing a python code. Each coding block can be connected in series or parallel, then executed in real time. User can directly change the numerical values and/or array size of each coding block in real-time. The develop visual script tool allows the user to directly print a complete-executable python script, based on the coding blocks setup by user. This project aims to develop a graphic user interface (GUI) software to integrate all the visual script tools developed by UROP students. The software is required to output a python file that contains all the code blocks that user had configured in the interface. In addition, students will further refine each visual script tools to ensure the consistency. Furthermore, students will include any necessarily new python functions into visual script tools. It is noted that the developed GUI software shall be modular, to allow expansion of functionality in future. The developed software will be deployed into classroom teaching in AY2026-2027. **The project scope includes:** **(1) Literature review on relevant python-packages;** **(2) Review the visual script tools developed by past UROP team,** **(3) Introduce new python-package in visual script tools, and** **(4) Develop a software interface to integrate all visual script tools.** Students are expected to develop the following skills (**learning outcome**): (1) To be familiar/skill with python programming; (2) To understand the design principles, and (3) To understand the difference between design requirement and user experience. The deliverable outcomes by the FYP students are: (1) Integration of multiple visual script tools into a single software interface; (2) A software with modularity feature that allows future expansion, and (3) A software interface that allows user to configure coding blocks and print python script; **Prerequisite:** Python knowledge is essential.
Student Workload Distribution	Student 1: on development of GUI software for visual script tools with python script printing capability.
	Student 2: on integrate the visual script tools and introduce new python-package in visual script tool.
Supervisor	GOH Shu Ting, shuting@nus.edu.sg
Laboratory Work	Computer
No. of students	2
CA1 requirements	Present the basic outline of visual script software with selected functionality.
CA2 requirements	Demonstrate the full functionality of the visual script software.

ID: SP77	This FYP proposal is for 3+1+1 students at NUSRI Suzhou
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Design and Optimization of Photonic Chips Based on Mach–Zehnder Interferometers (MZIs) Aiming for Photonic Neural Networks (PNN)
Summary (200 – 400 words)	Photonic chips, featuring ultrahigh speed and massive parallelism, have emerged as a promising new computing architecture to overcome the limitations of Moore's law. They have attracted significant academic interest for applications in data processing, neuromorphic computing, and artificial intelligence accelerators. Among various photonic architectures, Mach–Zehnder interferometer (MZI)-based designs have been widely adopted due to their fabrication robustness, ease of modulation, and flexibility in implementing matrix operations. However, MZI-based photonic chips also face inherent challenges, such as relatively large footprint, fabrication-induced phase errors and non-ideal modulation linearity. These issues can degrade system-level performance through crosstalk and accumulated phase deviation This project aims to investigate and optimize MZI-based photonic chips from both device and system perspectives. At the device level, the project will analyse the trade-offs in waveguide design, phase shifter configuration, and layout compactness to balance size, loss, and modulation efficiency. At the system level, error mitigation strategies will be developed to compensate for fabrication deviations and inter-channel crosstalk, thus improving the chip performance for computing and other applications. The **project scope** includes: (1) Literature review of photonic chip architectures and MZI-based device designs; (2) Simulation and modelling of MZI phase shifters; (3) Optimization of MZI for reduced footprint and improved modulation performance; (4) System-level error analysis and compensation strategies for large-scale MZI arrays; (5) Integration and performance evaluation of optimized MZI-based photonic chips. Students are expected to develop the following skills (**learning outcome**): (78) Understand the working principles and limitations of MZI; (79) Gain experience with photonic design tools and simulation software; (80) Learn how to analyse device imperfections and their impact on system performance; (81) Develop skills in system-level modelling, error mitigation techniques, and optimization strategies for photonic chips. The deliverable outcomes by the FYP students are: (1) A detailed review and analysis of MZI-based photonic chip design; (2) Optimized MZI device layouts with simulation results on modulation performance and parameter trade-offs; (3) Error mitigation algorithms and compensation techniques for MZI-based photonic systems; (4) A complete design framework for an optimized MZI-based photonic computing architecture. (5)Simulation demonstration of PNN using the MZI enabled photonics integrated circuits **Prerequisite:** A basic understanding of photonics or an interest in integrated photonic systems is recommended. Familiarity with simulation tools (such as Lumerical, COMSOL, or equivalent) would be helpful but not strictly required, as relevant training can be provided during the project.
Student Workload Distribution	Student 1: Focus on device-level design and optimization, including waveguide and MZI phase shifter modelling
	Student 2: Focus on system-level simulation, error analysis, and compensation strategies for large-scale MZI arrays.

Supervisor	Chengkuo Lee, elelc@nus.edu.sg
Laboratory Work	Computer, Photonic simulation software.
No. of students	2
CA1 requirements	Preliminary literature review, basic device modeling, and initial system-level simulation framework with error analysis concepts.
CA2 requirements	Complete device and system optimization for MZI-based photonic chips, including final simulation results and integrated design framework; Simulation of applications in PNN

ID: SP78	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Title of Project	FMCW radar with ADALM-PLUTO software defined radio
Summary (200 – 400 words)	The objective of the project is to build an FMCW radar with the ADALM-PLUTO The ADALM-PLUTO is a software defined radio that can transmit and receive signals over a wide frequency range. In this project, the ADALM-PLUTO is used to research and develop an FMCW radar system. The **project scope** includes: (1) Literature review of FMCW radar; (2) Review of the ADALM-PLUTO; (3) Modification of the ADALM-PLUTO to add the internal receiver and transmit channel; (4) Selection of antennas; (5) Development and demonstration of the FMCW radar. Students are expected to develop the following skills (**learning outcome**): (82) To understand FMCW radar; (83) To understand the functional behavior of the ADALM-PLUTO; (84) To apply signal processing; (85) To develop the FMCW radar; (86) To test and demonstrate the FMCW radar on realistic targets. The achievable outcomes by the FYP students are: (1) Development of the FMCW radar, including the ADALM-PLUTO code; (2) Fabricated and tested FMCW radar, including antennas; This project requires two students who are keen to work together on the development of a spectrum monitor the ADALM-PLUTO.
Student Workload Distribution	Student 1: Develop the FMCW hardware, including the antennas and the modification of the ADALM-PLUTO.
	Student 2: Investigate FMCW, develop the necessary software in the ADALM-PLUTO, including the FMCW radar.
Supervisor	Koen Mouthaan k.mouthaan@nus.edu.sg
Laboratory Work	Bench-top instruments
N0. of students	2
CA1 requirement	Literature review, familiarization with FMCW, testing of the ADALM-PLUTO;
CA2 requirement	Development of the FMCW radar, including the processing and demonstration of the system on realistic targets.

ID: SP79	This FYP proposal is for 3+1+1 students at NUSRI Suzhou
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Mobile Indoor Navigation system
Summary (200 – 400 words)	In this project, our objective is to investigate and developed an indoor localization and navigation systems for helping visitors to navigate the hospital/shopping malls etc. In terms of hardware, a few possibilities is possible, examples Bluetooth Low Energy (BLE) technologies or Ultra-Wide Bandwidth (UWB) technologies. The **project scope** includes: (1) Literature review of indoor localization system; (2) Literature review of navigation systems (3) Development of wireless node using Raspberry Pi/ESP; (4) Development of localization algorithms. (5) Development of mobile app for navigation. Students are expected to develop the following skills (**learning outcome**): (1) To understand basic knowledge and algorithms of localization and its key components; (2) Server and App development (3) Embedded system programming The achievable outcomes by the FYP students are: Development of a mobile vital signs monitoring system. This project can take up to 2 students: Student 1: Setting up of prototype infrastructure in lab and database and server and algorithms Student 2: Setting up of prototype infrastructure in lab and navigation app on mobile device There is an existing hardware from past students, we will make use of that and focus more on the algorithms and software analytics for this fyp. **Prerequisite: Must have some experiences in embedded systems, comfortable with programming**
Student Workload Distribution	Student 1: Setting up of prototype infrastructure in lab and database and server and algorithms.
	Student 2: Setting up of prototype infrastructure in lab and navigation app on mobile device.
Supervisor	Arthur Tay, eletaya@nus.edu.sg
Laboratory Work	Computer
No. of students	2
CA1 requirements	Literature review and software platform/hardware. Develop algorithm.
CA2 requirements	Development of localization and navigation system

ID: SP80	This FYP proposal is for 3+1+1 students at NUSRI Suzhou
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Reinforcement Learning for Adaptive Resource Allocation and Scheduling in 5G/6G Communication Networks
Summary (200 – 400 words)	This is a state-of-the-art project in Communications/Networks domain. In 5G/6G wireless networks, dynamic resource allocation (e.g., spectrum, power, slots) and user scheduling are critical for maximizing throughput, reducing latency, and ensuring fairness under fast-changing conditions. Traditional rule-based or optimization-based schedulers struggle with adaptability. This project explores **Reinforcement Learning (RL)** as a tool to build intelligent, real-time, adaptive resource allocation and scheduling agents. A good number of simulation environments seem to be available (ns-3, Simu5G, etc). Starting from baseline methods like round robin, students can explore Proportional Fair (PF) Scheduler, Max C/I (Channel-aware) scheduler, etc. One student can attempt to design RL-based scheduler for user scheduling in dense networks and other can attempt on multi-agent RL for resource allocation. Several metrics are possible for evaluation - user throughput, latency, RB utilization, packet drop rates, etc. For this project, **public real-world datasets are limited**, primarily due to proprietary restrictions in telecom operations. However, there are **several high-quality simulated or synthetic datasets and open-source environments** that can be used for training and benchmarking RL agents for both **resource allocation** and **user scheduling** tasks. The ***project scope*** includes: 1. Literature review of 5g/6g scheduling methods and RL; 2. Use of Machine learning tools to implement the methods; 3. To evaluate the performance of the methods and perform a comparative study. Students are expected to develop the following skills ***(learning outcome***): 1. To understand basic knowledge of adaptive resource allocation methods in networks 2. To evaluate a given ML/DL method and to use appropriate metrics indicated The ***achievable outcome*** by the FYP students for the CA assessment are: 1. To identify and implement scheduling methods and ML/DL methods 2. Performance Evaluation - influencing parameters; accuracy of prediction, etc 3. To use two different RL-based methods and evaluate the performances. **Expected Pre-req Skills** – Python related Python packages/Machine learning packages; must be able to interpret and analyse data. If there are two students to work on the project, each student should carry out two different methods for a given dataset and perform all-to-all comparison.
Student Workload Distribution	Student 1: A base model and one scheduling algorithm – joint effort, one individual learning model and implementation, compare with Student 2; Can try any novel hybrid method;
	Student 2: A base model and one scheduling algorithm – joint effort, one individual learning model and implementation, compare with Student 1; Can try any novel hybrid method;
Supervisor	A/Prof Bharadwaj Veeravalli, elebv@nus.edu.sg
Laboratory Work	Software/Laptop/ ML/DL Python related packages
No. of students	2
CA1 requirements	Project scope (1) and (2); Students must be familiarize themselves on the existing algorithms/methods; Relevant programming tools must be learnt and must demonstrate small scale relevant examples
CA2 requirements	To implement and evaluate the performance of hybrid/novel ML based methods – demonstration of a full-fledged simulation with relevant dataset.

ID: SP81	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	Smart current sensing using advanced magnetic sensors
Summary (200 – 400 words)	Current measurement is crucial for ensuring the safe and efficient operation of electrical systems, including electric vehicles (EVs), by monitoring and controlling power flow. It helps diagnose issues, prevent equipment failures, and avoid hazards like short circuits and overloads. For both industrial settings and EVs, accurate current measurements optimize energy consumption and maintain proper functionality, managing battery health and preventing component damage. In renewable energy systems, current measurement maximizes energy harvest and ensures reliable integration with the grid, supporting EV charging infrastructure. In this project, we propose to develop a low-cost and high-accuracy current meter using a tunnelling magnetoresistance (TMR) sensor. Compared to coil-based current meters, the TMR sensor offers several advantages, including higher sensitivity, low power consumption, better linearity, and a smaller form factor. These benefits allow for more precise measurements and compact designs, making the device suitable for a wide range of applications, including portable electronics and electric vehicles. This project aims to leverage these advantages to create a superior current measurement solution that meets modern demands for accuracy and efficiency. The **project scope** includes: 1) Review current measurement techniques, particularly TMR based current sensors. 2) Define the requirements and specifications for the current sensor. 3) Develop hardware/software for the current sensors; calibrate the prototype for accurate current measurement. 4) Conduct extensive testing to ensure performance meets the required standards. 5) Validate the prototype against various benchmarks and scenarios. Students are expected to develop the following skills (**learning outcome**): 1) Understand the working principle of a wide range of current measurement techniques. 2) Design and implementation of an intelligent sensing system from devices to system and applications that cover both hardware and software aspects as well as engineering integration. 3) Advanced signal processing techniques; Translational research and development. The deliverable outcomes by the FYP students are: 1) A working prototype of a low-cost, high-accuracy current meter using a TMR sensor. 2) Signal conditioning and processing circuit for accurate current measurement. 3) Performance evaluation and comparison with conventional coil-based current meters in terms of accuracy, sensitivity, power consumption, and form factor. 4) Final report documenting design, implementation, testing results, and potential applications in EVs, renewable energy systems, and portable electronics. **Prerequisite:** Prior experience of hardware and software implementation is a must.
Student Workload Distribution	Student 1: Design and build the TMR-based current sensing hardware; develop the signal conditioning circuit; test and optimize hardware performance.
	Student 2: Develop hardware and software for data acquisition and processing; analyze measurement accuracy; compare results with other types of sensors.
Supervisor	Wu Yihong; email: elewuyh@nus.edu.sg
Laboratory Work	Bench-top instruments, electronic components, magnetic sensors, computer
No. of students	2
CA1 requirements	Prepare technical specs and block diagram, design and build sensing circuits, and develop hardware and software for signal processing.
CA2 requirements	Testing, evaluation and improvement of the device at system level; demonstration of current measurement using the developed device.

ID: SP82	**This FYP proposal is for 3+1+1 students at NUSRI Suzhou**
Academic Year	AY 2025/2026 (September 2025 – May 2026)
Project Title	SPICE Modeling and Circuit Simulation of Ionic Synaptic Devices for Neuromorphic Computing
Summary (200 – 400 words)	Neuromorphic computing has been researched as a promising paradigm to overcome the limitations of traditional von Neumann architecture by mimicking the brain's energy-efficient and parallel processing capabilities. Ionic synaptic devices, which utilize ion migration to emulate biological synapses, have shown great potential for implementing neuromorphic systems thanks to their low-power operation and analog programmability. These devices can replicate key synaptic functions such as short-term plasticity (STP) and long-term potentiation/depression (LTP/LTD), making them ideal for brain-inspired computing applications. This project aims to develop a SPICE-compatible model for ionic synaptic devices and simulate ionic synaptic device based circuit, demonstrating their application in neuromorphic circuits. The proposed work will enable systematic exploration of device-circuit interactions, accelerating the development of energy-efficient neuromorphic systems for pattern recognition, edge computing, and adaptive control applications. The **project scope** includes: (1) Literature review of ionic synaptic devices and circuits, especially on modelling and simulation; (2) Develop physics-based SPICE model for ionic synaptic devices; (3) Validate the model in standard circuit simulation with experimental data from literature. (4) Simulate ionic device based neuromorphic circuits. Students are expected to develop the following skills (**learning outcome**): (1) To understand working principles and device physics of electronic and ionic devices; (2) To be skilled on physics based SPICE device model for ionic synaptic devices; (3) To be skilled on circuit simulation for ionic synaptic device based standard and neuromorphic circuits. The deliverable outcomes by the FYP student are: (1) To develop SPICE compatible device model for ionic synaptic devices; (2) To simulate OECT-based standard circuits and neuromorphic circuits; (3) To improve the device and circuit simulation results based on the comparison with experimental results. **Prerequisite:** Prior knowledge on semiconductor and device physics is a must.
Student Workload Distribution	Student 1: on SPICE device model, mainly physics based SPICE device model for ionic synaptic devices.
	Student 2: on circuit simulation, including simulation for standard circuits and neuromorphic circuits.
Supervisor	Zhu Chunxiang, E-mail: elezhucx@nus.edu.sg
Laboratory Work	Computer
No. of students	2
CA1 requirements	Design and simulation of device level SPICE model for ionic synaptic devices. Circuit simulation of ionic synaptic device based standard circuits.
CA2 requirements	Simulate and understand the influences of various design parameters on ionic synaptic device performance. Ionic device-based circuit simulation for standard and neuromorphic circuit.