2025 優秀外國青年來臺蹲點計畫 成果報告書

研習主題：次世代高效率馬達及多軸同步運動控制技術的學習與應用

1. 計畫摘要：

(1) 專案簡介：

TEEP Team 參加校內全英課程

此次專案共錄取了五位來自越南胡志明工業大學電機工程學系的大四學生以及一位博士在學講師。在台期間之研究主題由雙方學校與系所之指導教授討論後共同決定。在國立宜蘭大學機械與機電工程系先進動力與能源實驗室實習的兩個半月的過程中，實驗室提供多項協助及多元學習，包括學伴的安排、專業技能的訓練、多元文化交流以及專題製作。

此專案旨在加強與姊妹校(合作大學)的聯合教學與研究並為兩校學生創造一個合作學習的環境，強化務實交流。這個跨國、跨校、跨系所的團隊由國立宜蘭大學的 12 名學生和 5 名指導老師(含業界師資及跨領域師資)，以及胡志明工業大學的 4 名指導老師和 5 名 TEEP 學生組成。此團隊專注於人才培育、聯合教學與學習，並整合了各項研究和技術領域的資源，具體建立務實的雙邊合作關係，落實 TEEP 計畫的目標。

(2) 在台停留時間:

2024/10/29~2025/01/15

(3) 地點:

國立宜蘭大學　機械與機電工程學系　先進動力與能源實驗室

(4) 專案執行:

a. **參加 Advanced Power and Energy Center/APEC，內部培訓課程:** 包括專業外語、電機工程概論、馬達調機理論、馬達控制、馬達能效測試、Human Machine Interface/HMI 程式設計以及高階變頻器的原理、設定及多軸運動控制的學理基礎及應用。

b. **專案研究：**根據 TEEP 成員的背景，研究主題在與 APEC 的指導老師討論確定後，學習及研究人內容涉及高階變頻器的學理基礎與應用、馬達調機、運動控制和馬達的能效測試。主題經過精心選擇，旨在作為未來雙邊進一步的合作，以及作為後續參與 TEEP 學員進一步學位研究和未來下個梯次到宜蘭大學學習的 TEEP 成員的基礎。

c. **企業交流：**通過與台灣領先企業的互動，增進 TEEP 成員對台灣教育、產業、經濟及文化的理解。期望台灣成為 TEEP 學員未來在繼續深造或就業發展的首選夥伴。

d. **以英語為主要溝通語言：**在全球化的社會中，英語是一項必備技能，特別是在台灣。由於少子化

的影響，台灣致力於招聘優秀外國人才來台攻讀學位與工作。為了培養符合未來需求的人才，本計劃全程使用英語，包括討論、每週學習報告和最終成果展示。

(5) 實習生：

本梯次，我們共錄取了來自越南胡志明市工業大學電機工程學系的五名學生及一位博士在學講師，分別為 Van Thi Kieu Nhi, Nguyen Hoc Vuong, Nguyen Thien Thuat, Pham Dinh Chuong, Phan Han Hoan, Vu Xuan Sang，申請學生必需先經過當地學校指導老師的面試及評選，取得原就讀系所主管推薦後才進入指導老師的最後評選。

指導老師與 TEEP 學生的定期學習討論

指導老師帶領 TEEP 與學伴進行業界參訪

(6) 財務報告

TEEP@AsiaPlus Financial Report		
姓名	在台期間（月）	補助
Van, Thi Kieu Nhi	2.5 (113 年 10 月 29 日~114 年 1 月 15 日)	37,500
Nguyen, Hoc Vuong	2.5 (113 年 10 月 29 日~114 年 1 月 15 日)	37,500
Nguyen Thien Thuat	2.5 (113 年 10 月 29 日~114 年 1 月 15 日)	37,500
Pham Dinh Chuong	2.5 (113 年 10 月 29 日~114 年 1 月 15 日)	37,500
Pham Han Hoan	2.5 (113 年 10 月 29 日~114 年 1 月 15 日)	37,500
Vu, Xuan Sang	2.5 (113 年 10 月 29 日~114 年 1 月 15 日)	37,500
總計		225,000

2. 學習成果

(1) 專案成果影片:

1. https://www.youtube.com/watch?v=usbkp9ebaPU
2. https://www.youtube.com/watch?v=UsXHPnaVO34

(2) 專案成果:

姓名	Van, Thi Kieu Nhi	**電子郵件**	vanthikieunhi@iuh.edu.vn
	Nguyen, Hoc Vuong		nguyenhocvuong832003@gmail.com
	Nguyen Thien Thuat		thienthuat16022003@gmail.com
	Pham Dinh Chuong		chuongphamdinh2003@gmail.com
	Pham Han Hoan		hanhoan1301@gmail.com
	Vu, Xuan Sang		sangvu0504@gmail.com
指導教授	Dr. Cheng-Hu Chen (NIU, TW), Van, Thi Kieu Nhi (IUH, VN)		
主題	**次世代高效率馬達及多軸同步運動控制技術的學習與應用**		

研究摘要:

隨著台灣科技產業的持續進步，台灣製造業不僅已經邁入工業 4.0，更進一步向工業 5.0/AI 發展，強化人工智慧技術的導入。由於近年來台灣出生率持續下降，各行各業對於導入自動控制技術及減少人力資源投入的需求日益增加，這已成為台灣各級產業面臨的主要挑戰。在近幾屆的台北自動化展上，可以清楚看到產業的發展趨勢，自動化技術與智能化整合技術已廣泛應用於生產線的各個階段，無論是前端、中端還是後端，整個製程的每個環節都不例外。

馬達作為各種自動化設備的主要動力來源，其重要性不言而喻。全球工業用電中有 70%是由馬達消耗，而全球用電量有一半消耗在馬達。在全球面臨氣候變遷、減少石化燃料使用以及核能爭議等挑戰的背景下，各國普遍面臨電力供應緊張或電費高漲的問題。因此，提高馬達的效率和功率密度已成為各國政府及電機製造業者透過法律規範與政策推廣的重點。

在此次的研究中，參與的學員設計並實現了一套同步單刀旋轉飛剪裁切系統。同步飛剪裁切系統主要應用於金屬加工、皮革加工及自動貼標等需要高精度與高效率的自動化製造程序。本次專案開發的主要特點是利用同步磁阻伺服馬達實現切刀速度與材料運動的精確同步控制，確保切割精度並避免損壞材料。整個系統由感應馬達作為輸送馬達、同步磁阻馬達作為切刀馬達，分別由兩組伺服驅動器和控制器獨立控制。TEEP 學員們使用控制器的軟體進行控制參數設置與系統調整。為了模擬真實應用場景，系統還加入了兩片切刀以模擬外部慣量。參與者同時深入學習並實踐了運動控制、電子凸輪曲線設計、馬達調試及 PID 控制器等相關控制理論，將理論知識與實際應用緊密結合。

在另一項研究中，學員們進行了 IEC 高效率馬達能效標準的研讀與高效率馬達產品規格的相關研究。他們系統性地整理了 ABB、Siemens 和 WEG 三家世界領先公司所提供的技術文件，並進行馬達損失的詳細計算。基於這些研究成果，學員們開發了一款使用者友好的應用軟體，旨在幫助最終用戶更清晰地了解高效率馬達的優勢。高效率馬達不僅在性能上有所提升，還能顯著降低能量損耗、節省成本、減少二氧化碳排放。此外，學員們還熟練使用了 Danfoss 與 Vacon 等多款變頻器操作次世代高效率同步磁阻馬達，從而獲得了進一步的實際操作經驗。

通過此次專案，參與的 TEEP 學員不僅在專業技能上得到了顯著提升，還掌握了許多非常實用的技能，依據過去培育的經驗，這些技能將對他們未來的職業發展產生正向的影響。此外，學員們也成功融入了當地學生的學習和生活環境，跨文化的交流與合作使他們在專業成長的同時，也增強了文化理解與全球視野。他們學會了如何在多元文化背景下有效合作與溝通，不同背景的學生之間能夠開展知識與經驗的分享，進一步促進了跨文化的理解與合作，為未來更深層次的國際合作奠定了堅實的基礎。

成果:

此專案之成果可以分成四個部分:

(1) 不論是宜蘭大學 APEC 和胡志明市工業大學電機工程學系的學生皆能夠辨別不同交流馬達的差異。此外，他們學會了如何測試馬達、觀察數據，並且依照 IEC 的規範來評斷測試馬達之能效等級。

(2) TEEP 學生不僅學習了馬達測試與調機的理論，還在實踐中應用了這些知識，進一步實現同步磁阻馬達和感應馬達的調機知識與技術。此外，他們還應用了高速工業通訊界面 EatherCAT 及電子凸輪，實現同步運動控制技術並成功的開發了一套同步飛剪控制系統的實驗平台。

(3) TEEP 學生們學會了如何使用高階變頻器和運動控制器來控制不同型式的伺服交流馬達。

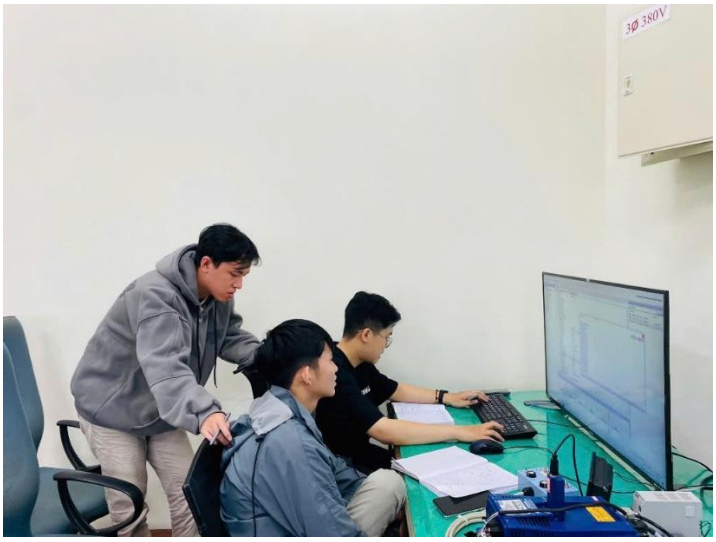
(4) 宜蘭大學 APEC 和胡志明市工業大學電機工程學系的學生獲得了與來自不同文化背景和語言的團隊合作的能力，成功合作並且完成了預期設定的學習目標。

(5) TEEP 學生設計出實用的馬達損失計算軟體，此軟體不僅可以讓買家快速了解馬達的能效等級，還能讓設計端快速了解還須降低多少損失比例來達到下一個能效等級。此外，此軟體還能計算每個能效等級之間可以節省多少能源並且轉換成回收年限，讓使用者使用一個軟體就能解決所有問題。

TEEP 學員學習心得:

Nguyen Hoc Vuong:

My name is Nguyen Hoc Vuong, student from industrial university of Ho Chi Minh city, this internship at APEC was an extraordinary journey that profoundly shaped both my professional and personal development. APEC's challenges fostered growth, providing an ideal environment for research and learning. The knowledge imparted by APEC was truly invaluable. During my time at APEC, I had the chance of working on the motion control project for a



TEEP Students Do The Synchronous Single-Knife Rotary Shear System

synchronous single-knife rotary shear, which expanded my understanding of the control field. I gained hands-on experience controlling synchronous reluctance motors, known for their energy efficiency and reduced reliance on rare earth materials. Additionally, I worked with advanced inverters from leading manufacturers such as KEB, significantly enhancing my expertise in motor control. APEC provided the unique opportunity to apply theoretical concepts to real-world challenges immediately.

Graduates' Career Sharing to APEC and TEEP Students

Beyond technical skills, this experience enriched my worldview. Immersion in a developed country's environment broadened my horizons, while invaluable lessons from my professor reshaped my mindset. His guidance on seizing opportunities helps me overcome fears of failure and unknown challenges.

This internship not only refined my technical abilities but also deepened my self awareness, paving the way for future growth. I extend my heartfelt gratitude to my professor for mentorship and unwavering support.

Nguyen Thien Thuat:

My name is Nguyen Thien Thuat, a fourth-year student majoring in Automation and Control Engineering Technology at Ho Chi Minh City University of Industry (IUH), Vietnam. From November 1, 2024, to January 15, 2025, I had the privilege of participating in the Taiwan Experience Education Program at National Ilan University (NIU).

During my time at NIU, I expanded my knowledge of synchronous reluctance motors and gained practical experience in tuning these motor systems using Combivis 6 software. I learned to evaluate key technical parameters, including current/torque, speed, and position loops, which are critical for calibrating synchronous reluctance motors. In addition, I participated in classes at NIU and had the opportunity to interact with international students from Taiwan, Russia, Malaysia, and other countries. I explored Taiwan's famous landmarks, such as Taiping Mountain, the Kavalan Whiskey Factory, Taipei 101, and the Taipei Zoo, while also enjoying its local cuisine and culture. Furthermore, I participated in field trips to leading companies in Taiwan, including Rechi and Liang Chi.

TEEP Team are Learning the Component of the Motor

The knowledge and experiences I gained from this program are invaluable. They have enhanced my technical expertise, boosted my confidence, and broadened my worldview. I am confident that I can apply this newfound knowledge to my projects at IUH and beyond, supporting my future career development.

I am deeply grateful to National Ilan University for creating this meaningful program for me to study here. I also extend my heartfelt thanks to the host professor at APEC, whose dedicated guidance has imparted valuable lessons.

Vu Xuan Sang:

Trip to Taipingshan

My name is Vu Xuan Sang. I'm in my fourth year of my bachelor' s degree. I'm currently studying Automation and Control Technology at IUH. And I'm one of the Taiwan Experience Education Program (TEEP) students from November 1, 2024, to January 15, 2025.

This is my first time studying abroad but I did not encounter any serious difficulties. Under the care of Professor Chen, I had a very good learning experience at NIU. I have taken some classes at NIU which are very different because of the many modern facilities that allow students to practice and research real projects.

During our time in Taiwan, we visited remarkable places and joined meaningful events, such as Taipingshan Mountain, Chung-Hwa Junior High School, Taipei 101, Taipei Zoo, and Ximending Street. Each experience was unforgettable, and I cherished making friends with international students.

At Professor Chen's laboratory (APEC), the facilities are state-of-the-art and comparable to many companies out there. So, what we do here is very similar to the industries outside. APEC is a research lab that supports students in developing both their professional knowledge and growth mindset. When I came here, I had access to advanced technologies from the world's leading companies.

I was able to study under the guidance of Professor Chen, which is the most precious thing that not everyone is fortunate enough to have. From him, I gained not only deep professional knowledge but also critical life skills, such as serious attitude at work as well as staying composed when solving problems and communicating professionally with partners. These are essential qualities that I believe every student should strive to develop for a successful and rewarding career. Although we have learned specialized knowledge, under the guidance of Professor Chen, we have had clear concepts of them. Now we can apply them to carry out projects in real industries.

In this internship, my team carried out a project related to the topic Motion Control Technologies with Modern AC Machines. And we successfully applied it to the Rotary Knife system. This is an extremely convenient system, with high automation when it can cut products such as paper, steel, plastic, …

I sincerely thank the NIU leadership for supporting international students like me and creating an environment for growth. Over the past three months, I have significantly improved in both specialized knowledge and mindset, and I am deeply grateful to Professor Chen for his invaluable guidance.

Phan Han Hoan:

My name is Phan Han Hoan, a student at the Industrial University of Ho Chi Minh City. My major is renewable energy. I had the privilege of participating in the TEEP program from November 1st,2024 to January 15th,2025. This was my first experience studying abroad, and thanks to the professor's support

with accommodation and study facilities, along with the warm assistance of NIU students, I quickly adapted to this new environment. I am deeply grateful to the OIA for arranging this opportunity, which allowed me to experience innovative teaching methods and engage with international students. Guided by the professor and APEC students, I explored high-efficiency motors, gaining valuable insights into their significance and their impact on the environment, industry, residential use, and energy sectors. Field trips to enterprises provided an eye-opening perspective on production processes and a chance to connect with NIU alumni, which was both inspiring and educational. A standout moment was meeting the director of a renewable energy company whose groundbreaking business model differed greatly from the companies I've worked with in Vietnam. I sincerely thank NIU's leadership, Host Professor, and all the students who made this enriching and transformative experience possible.

TEEP Students Were Discussing Their Project

Pham Dinh Chuong:

My name is Pham Dinh Chuong. I am a fourth-year student majoring in Industrial Electricity at Ho Chi Minh City University of Industry. During this internship, I developed my engineering skills, which helped me become more disciplined to develop myself in both work and life. I visited famous places in Taiwan such as: Taiping Mountain, Taipei 101 building and some local companies: Rechi Precision, Liang Chi Industrial.

My time at APEC helped me gain a deeper understanding of high-efficiency motors—how to improve high-efficiency motors, reduce energy consumption and minimize operating losses. Learned how to operate electric motors and inverter controllers, analyze technical articles and search for accurate information effectively. I also explored developing software to advise users on upgrading to more efficient engines, contributing to global sustainability and the goal of Net Zero Carbon Emissions. This overseas internship was a transformative experience, providing growth, inspiration from the host professor and master's students at APEC, as well as a deeper understanding of Taiwan's culture and academic excellence. This journey will positively impact on my future career development. Thank you to the faculty at IUH, NIU leadership, and the host professor and master's students at APEC for supporting me during this internship.

TEEP Team are Having Discussion For the Project