2024 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其控制技術與應用

1. 計畫摘要：

(1) 專案簡介：

此次專案共錄取了四位來自越南胡志明工業大學電機工程學系的四位大四學生。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三個月的過程中，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 10 名學生和 5 名指導老師，以及胡志明工業大學的 3 名指導老師和 4 名學生組成。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。

多元豐富的戶外及戶內實作課程

(2) 在台停留時間:

2024/05/31~2024/08/23

(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四名學生，Nguyen Phi Truong, Hoang Van Loc, Nguyen Van Dac and Vo Duc Huy，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 學生參訪蘭陽博物館

(6) 財務報告

TEEP@AsiaPlus Financial Report		
姓名	在台期間（月）	補助
Nguyen Phi Truong	3 (5 月 31 日~8 月 23 日)	41,129
Hoang Van Loc	3 (5 月 31 日~8 月 23 日)	41,129
Nguyen Van Dac	3 (5 月 31 日~8 月 23 日)	41,129
Vo Duc Huy	3 (5 月 31 日~8 月 23 日)	41,129
總計		164,516

2. 學習成果

(1) 專案成果影片:

https://www.youtube.com/watch?v=o-6AlZFICtg

https://www.youtube.com/watch?v=R61IpqR2_1U

(2) 專案成果:

姓名	Nguyen Phi Truong	**電子郵件**	20068171.truong@student.iuh.edu.vn
	Hoang Van Loc		Hoangvanloc1818@gmail.com
	Nguyen Van Dac		Dacnguyenvan5@gmail.com
	Vo Duc Huy		Huyvo.310302@gmail.com
指導教授	Dr. Cheng-Hu Chen (NIU, TW), Thanh Phuc Nguyen (IUH, VN)		
主題	次世代高效率馬達及其控制技術與應用		

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。

在這樣的背景下，本次研習特別為 TEEP 學員準備了次世代高效率馬達——同步磁阻馬達（Synchronous Reluctance Motor），並結合高階變頻器與人機界面控制器，讓學員們深入了解先進的交流電機控制技術，並比較傳統感應馬達與次世代高效率無磁石同步馬達的差異。在為期三個月的培訓過程中，TEEP 學員有機會對傳統感應馬達與新型同步磁阻馬達進行全面比較。在實機操作過程中，學員們搭建了一個專用平台，在相同的轉速和加速度曲線下，詳細比較分析了兩種馬達在響應速度、穩定性、剛性和噪音等方面的表現。這樣的比較不僅有助於學員理解新型馬達在實際應用中的優勢與劣勢，還為後續技術優化提供了寶貴的數據。

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，並進行比較以了解各種交流馬達的優勢和劣勢。

(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最佳調機。此外，他們還能透過調整各個閉環增益參數以及加減速曲線來滿足在不同需求下馬達之最佳響應。

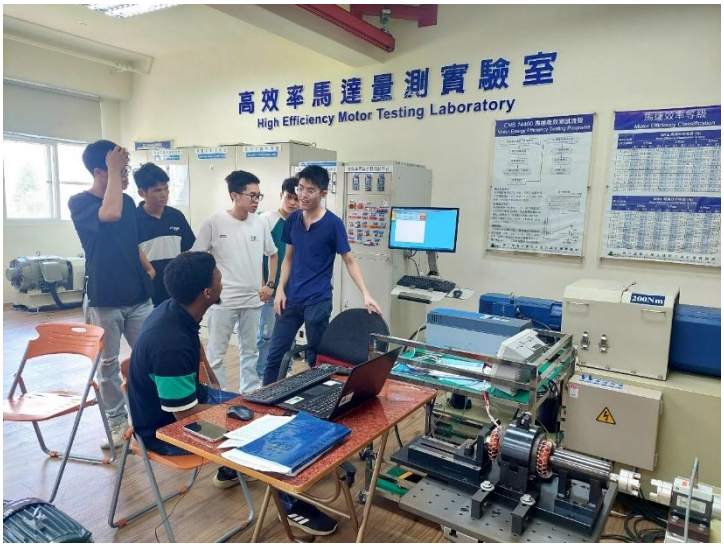
(3) TEEP 學生們學會了如何使用高階變頻器和運動控制器來控制不同型式的伺服交流馬達。

(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。

TEEP 學員學習心得:

Nguyen Phi Truong:

The Taiwan Experience Education Program (TEEP) has been an incredible opportunity for me to gain new knowledge and apply it in practice. Studying and researching at the Advanced Power and Energy Center (APEC) at National Ilan University (NIU) has provided me with insights into motors, specifically Induction Motors and Synchronous Reluctance Motors.



APEC and TEEP Students Do The Motor Test Together

Having the chance to directly control these motors using the latest technology has been a remarkable experience. The Synchronous Reluctance Motor is widely regarded as the future trend in motor technology, and I never imagined I would have the opportunity to see or work with it until I joined the TEEP program.

In addition to my studies at APEC, I participated in various tours that allowed me to explore and learn about different aspects of Taiwan. These experiences enriched my knowledge in my major fields, daily life, and local culture. I visited historical sites, technological hubs, and natural landscapes, gaining unique insights into Taiwan's heritage and innovation. This program has been a wonderful experience for me, and I feel incredibly fortunate to have had the opportunity to study at APEC – NIU.

Hoang Van Loc:

Graduates' Career Sharing to APEC and TEEP Students

I feel incredibly honored and fortunate to have participated in the TEEP program at National Ilan University over the past three months. This opportunity has allowed me to learn, experience many new things, and enhance my personal value. Throughout my time studying and working here, the aspect that has provided me with the most knowledge and fresh insights has been motor control. At APEC, I had the chance to work with some of the most advanced motors, both synchronous and induction types. I learned how to work seriously, safely, diligently, and professionally, and gained a deeper understanding of the high-efficiency motor testing process. Beyond my time at APEC, I also had the opportunity to go on various excursions, exploring and learning around Taiwan. These experiences enriched my knowledge not only in technical fields like electric trains and power systems but also in everyday life and local culture. During this journey, I made the most of every moment, and it has been incredibly meaningful, helping me improve in many ways.

Nguyen Van Dac:

My name is Nguyen Van Dac. I started participating in the TEEP 2024 program from May 31 to August 23 at National Ilan University. During the 3-month TEEP program at NIU, I learned a lot about motor control. Under the guidance of the Host Professor and APEC members, I first learned the process of successfully tuning synchronous motors and induction motors. Next, I learned how to control the position loop and speed loop using **motion control** software. In the speed loop, I can control the motor at low and high speeds (**0-3000 rpm**). In the position loop, I can control the motor to rotate to the correct position quickly and smoothly. Next, we were introduced to motion control software. The software can help us control the speed mode, position mode, homing mode, synchronous mode of the master and slave motors. I can determine the best performance data to make the motor's rated parameters. I learned how to connect the servo motor to the **advanced**

Taiwan Culture Experience

inverter and **motion controller**.

At the High Efficiency motor test laboratory, we saw how motors are evaluated according to the standards of High Efficiency Motor (**IE3, IE4, IE5**). The field trips enriched my understanding, especially the role of electric motors in high-speed trains. The knowledge and skills I gained during these three months are highly applicable in today's modern industrial context. In addition to learning engineering, I also had the opportunity to experience the culture, education and daily life in Taiwan. The TEEP program is a great platform for foreign students to gain more academic knowledge and experience the culture of Taiwan. I thank NIU for giving me the opportunity to participate in the TEEP 2024 program.

TEEP Students Were Discussing Their Project

Vo Duc Huy:

During my three-month participation in the Taiwan Experience Education Program (TEEP) at National Ilan University (NIU), I gained a wealth of knowledge and practical experience in motor control under the guidance of the Host Professor. I practiced controlling both synchronous and asynchronous motors using KEB inverters through Combivis6 and Combivis Studio 6 software, focusing on adjusting control parameters, particularly in tuning the motor for smooth operation across a wide range of speeds. I also designed the Delta HMI interface and integrated the HMI screen into
motor control, as well as synchronized control of two motors. Additionally, I observed and learned from APEC members as they tested motors and checked various parameters. Furthermore, I had the opportunity to join classes with students at NIU, which provided me with deeper insights into the academic culture and teaching methods in Taiwan. My time here included cultural exploration trips that gave me a profound understanding of the region's history and development. My experience at NIU has been incredibly valuable, providing me with both theoretical knowledge and practical skills that will be highly beneficial for my future career. I am deeply grateful for the support and guidance of the Host Professor and the APEC team, and I look forward to applying what I have learned in my future research and career development.

Participated 2024 Taipei Computex Exhibition