

Planning and Development of Nuclear Engineering Program at Universiti Tenaga Malaysia (UNITEN)

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Abstract

Development and realization of nuclear engineering program at any educational institution is indeed very important to provide the human resource requirements of the nuclear power industry. Sufficient educational and training skills are required to ensure that the manpower needed by the nuclear power industry meets its high standard. The Center for Nuclear Energy (CNE), College of Engineering, Universiti Tenaga Nasional (UNITEN) is given the responsibility to undertake activities that promote developing human capital in the area of nuclear power and technology. Developing human capital in nuclear with required nuclear background and professional qualifications is necessary to support the implementation of nuclear power projects in the near future. One of its activities is to develop educational programs at UNITEN in the fields of nuclear power and technology. Before undertaking such program, inputs and recommendations from various institutions and relevant bodies are solicited to ensure that the educational program to be developed is equivalent if not better than similar program that is conducted in more established universities and institutions. The educational program must also meet the nuclear power industry needs and requirements. To develop and conduct the program, cooperation and Memorandum of Understanding (MOU) between UNITEN and universities and agencies that are involved in education and research in nuclear disciplines had been established. This paper elaborates the scope of cooperation and activities between UNITEN and the Malaysian Nuclear Agency, the Texas A&M University, College Station, Texas, United States and the Chulalongkorn University, Bangkok, Thailand, respectively. The scope and activities include exchange of experience, development of standard curriculum, sharing of research facilities, exchange of staff and technical visits.

Keywords: Nuclear Engineering, Mechanical Engineering, educational program, networking;

1. Introduction

With increasing energy demands for economic growths, Malaysia and other developing countries are facing challenges to meet the demands at a competitive price. Due to lack of new energy resources and to address the climate issues, solutions must be formulated to generate energy from alternative sources such as wind, solar, geothermal and nuclear. One of the most viable options is the nuclear energy. Nuclear energy provides a very stable base-load electricity supply and negligible carbon emission and thus should help in the promotion of low carbon economy (European Communities 2009). The introduction of nuclear energy in any country, Malaysia included, requires a long lead time, with concerted and comprehensive planning and development of appropriate institutional, legal and regulatory, technological, educational and training, and other related infrastructure. Among the key requirements are the need to establish the economic viability of nuclear power projects, a long-term national commitment for the nuclear energy option, a national pre-selection of the appropriate nuclear power plant type, a long-term spent-fuel management policy, compliance with the international system of nuclear governance, national capacity-building and public acceptance programme on nuclear energy.

Malaysia belongs to a group of ten newcomer countries that have the potential to develop nuclear power (Jewell 2011). These countries resemble the established nuclear power countries with respect to their capacities and motivation to develop nuclear power. In the middle of 2009, the Malaysian Cabinet decided to include nuclear power as an energy option for post 2020. Consequently, in May 2010, the Malaysian Government approved the setting up of the first nuclear power plant to operate from 2021. And eventually, in January 2011, the Malaysian Government formed the Malaysia Nuclear Power Cooperation (MNPC) to spearhead the country's push for nuclear power. The national utility company, Tenaga Nasional Berhad (TNB) is expected to be one of the key players in

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Malaysia's ambition towards building the first nuclear power plant (NPP) by 2021. As such, the need for national nuclear training hub intensifies in light of Malaysia's intention to pursue nuclear power. Recently the Universiti Tenaga Nasional (UNITEN) established a special nuclear energy unit known as the Center for Nuclear Energy (CNE). Sharing the same view with TNB, which is the parent company of UNITEN, the centre strongly believed that nuclear technology is the most viable and better alternative for a long-term energy source in Malaysia. This aspiration is in tandem with the government effort to secure sustainable development and to reduce dependency on fossil fuel as the main energy mix. As the education arm of TNB, UNITEN is given the responsibility to develop human resource capability in the area. The human capital needs and demands for a nuclear power plant are significant and require a careful planning and a long lead time to develop.

In preparing the human resources in nuclear power, the College of Engineering, UNITEN is taking the initiative to introduce a degree in Mechanical Engineering with specialization in Nuclear Engineering program and is considering offering the Degree in Nuclear Engineering program through a twinning program with a foreign institution. In preparation of the program, lessons learned from other countries are taken into consideration. Several models of cooperation have been undertaken in several countries to develop nuclear power program. In the Republic of Korea, in establishing a long-term human resources development program, the government created undergraduate nuclear engineering departments at several universities almost 20 years before the commissioned of their first nuclear power plant in 1978 (Choi et al. 2009). The education program includes cooperation with institutions in the United States, France, the United Kingdom, Australia and Germany. The success story of nuclear power program in Korea was indeed the manifestation of careful and visionary planning. In Indonesia, there are several on-going collaborations between Japanese and Indonesian universities in development of standard curriculum for Master of Science program, exchange of lecturers and exchange of students at post graduate levels where the emphasis of the collaboration is on nuclear human resources development (Subki 2008). And in Russia, cooperation between universities and R&D institutes has created specialists training system to meet the industrial demands for nuclear work forces that are ready to conduct research, engineering and production activities for the nuclear industry (Kryuchkov 2008).

This paper presents the roles and functions of the Center for Nuclear Energy, College of Engineering, UNITEN, and the networking activities and collaboration with the Malaysian Nuclear Agency, the Texas A&M University, College Station, Texas, United States and the Chulalongkorn University, Bangkok, Thailand in developing nuclear engineering program at UNITEN.

2. Center for Nuclear Energy

The Center for Nuclear Energy (CNE), College of Engineering, UNITEN was established to spearhead the development of nuclear engineering educational programs at UNITEN. The vision of the center is to be a leading centre of excellence and knowledge hub in nuclear power and engineering in Malaysia. CNE is committed to the advancement of nuclear energy through dedicated education and research activities that promote transfer of knowledge, innovations and industrial linkages. The objectives of the center are:

- To enhance the scientific and technical knowledge in nuclear energy and engineering by engaging and establishing research and development activities.
- To enhance the knowledge and technical skills of staffs and students in areas related to nuclear energy by participating and establishing education and training activities.
- To promote comprehensive strategies in supporting development of local nuclear-related industries.
- To participate and contribute in public information and public acceptance activities pertaining to national nuclear energy program.

To further consolidate the activities of center, terms of reference (TOR) of the center has been formulated and serve as the guidelines in implementing any activity. Accordingly, the powers, duties and functions of CNE are:

- To forward recommendations to the management of UNITEN on directions of nuclear education and training programs in UNITEN.
- To coordinate the implementation of nuclear education and training programs in UNITEN;

- To identify and assess the short-term and long-term education and training needs of UNITEN staff in the area of nuclear education.
- To monitor the nuclear education programs for undergraduate and postgraduate students at UNITEN.
- To provide recommendation to the management of UNITEN on the education and training needs of an individual staff.
- To monitor the progress of any Memorandum of Understanding (MOU) in nuclear between UNITEN and other parties.
- To inform the management of UNITEN on the implementation of any nuclear education and training programs and related activities through the dissemination of pertinent reports and information.

3. Cooperation and Networking Activities

To develop the nuclear engineering program in UNITEN, cooperation and inputs from several institutions were solicited. The cooperation is needed to learn from the experiences of more established institutions, locally and abroad. Since the year 2010, several networking activities were engaged between UNITEN and the institutions.

3.1 Memorandum of Understanding (MOU) with Malaysian Nuclear Agency (MNA), Bangi, Selangor

Since there is no nuclear reactor facility at UNITEN, cooperation with MNA is very important to ensure the success of the nuclear engineering program at UNITEN. Exposing students to the TRIGA Mark II research reactor at MNA would help students to understand the physics of nuclear reactor. Besides, research activities could be conducted at the reactor for the benefits of staff and students of UNITEN.

The MOU between UNITEN and MNA was formalized in December 2010. The main objective of the MOU is to exchange information in nuclear related areas and conduct joint research in nuclear engineering and technology. Under the MOU, four technical working groups (TWG) were formed to look into different area of interests. They are:

- TWG for Education and Training
- TWG for Research and Development
- TWG for Public Information and Public Acceptance
- TWG for Industrial Support

Under the TWG for Education and Training, several activities have been carried out. Currently, students from UNITEN are able to use facilities at MNA for final year research projects such as non-destructive testing (NDT) facility. In addition, collaboration in research projects and trainings has been finalized for staff of UNITEN and MNA. Staff of UNITEN has also participated in several workshops pertaining to nuclear power that were co-organized by MNA and the International Atomic Energy Agency (IAEA).

3.2 Cooperation with Texas A&M University (TAMU), College Station, Texas, United States

To help in benchmarking the educational program in nuclear engineering at UNITEN, cooperation with the Texas A&M University (TAMU), College Station, Texas is established. TAMU is selected because it has the largest academic, research and training programs in nuclear in the United States. TAMU is supported by two distinguished institutes, the Nuclear Power Institute (NPI) and the Nuclear Security Science and Policy Institute (NSSPI). At TAMU, there are facilities for research and training in the nuclear field such as nuclear reactors, several beam accelerators and a high-energy plasma laboratory. NPI and NSSPI are also involved in international cooperation through bilateral projects and multilateral cooperation throughout the world.

In August 2011, two professors from TAMU had visited UNITEN to initiate the cooperation between UNITEN and TAMU. In February 2012, the Vice Chancellor of UNITEN and the Dean of the College of Engineering visited TAMU to strengthen the networking. The scopes of the cooperation are:

- To look into the possibilities of signing an MOU between UNITEN and TAMU on academic and research collaboration.

- To identify areas of academic and research collaborations between UNITEN and TAMU.
- To establish linkages and exchange of information between College of Engineering, UNITEN and Department of Nuclear Engineering, TAMU.
- To review the course structure of Bachelor Degree in Mechanical Engineering with specialization in Nuclear Engineering program at UNITEN.
- To examine the course structure for Master in Nuclear Engineering and Bachelor in Nuclear Engineering programs at UNITEN.

From both visits, in principle both UNITEN and TAMU have agreed to expedite cooperation in the following activities:

- Exchange of staff between UNITEN and TAMU.
- Appointment of visiting professor from TAMU.
- Accommodate UNITEN staff attachment at TAMU.
- Appointment of lecturers from TAMU to teach post graduate program in nuclear engineering at UNITEN.
- Appointment of external examiner from TAMU.
- Access to teaching and learning materials from TAMU faculty.
- Submitting joint proposals for research grants in Malaysia and the US in nuclear related fields.
- Encourage sabbatical leave of UNITEN staff at TAMU.

3.3 Technical visit to Chulalongkorn University, Bangkok, Thailand

In general, the purpose of visit to Chulalongkorn University was to study the “Thai-Canadian Nuclear Human Resources Development Linkage Project” and the implementation of the project through their cooperation with the Canadian International Development Agency (CIDA) especially on Nuclear Power Plant (NPP) Human Resource preparation. Besides conducting academic programs in nuclear technology, the Department of Nuclear Technology, Faculty of Engineering, Chulalongkorn University (CU) had the experience in conducting a comprehensive and integrated approach in training nuclear workforce in Thailand.

The specific objectives of the visit to the Department of Nuclear Technology, Faculty of Engineering, CU are:

- To study the details on the Thailand-CIDA cooperation program on nuclear human resource development for Thailand.
- To discuss the academic curriculum related to nuclear engineering.
- To learn the academic staff planning and requirements in conducting nuclear engineering program.
- To study the facilities needed for the nuclear engineering program.
- To gauge students enrolment planning for the nuclear engineering program.
- To visit relevant laboratories at the Department of Nuclear Technology.

The visit was very successful in meeting the objectives. All the inputs, suggestions and recommendations will be taken into consideration during the developing and implementing stage of the Nuclear Engineering program at UNITEN.

4. Nuclear Engineering Program at UNITEN

Based on the benchmarking and networking exercises, UNITEN has decided to embark on establishing the nuclear engineering program under the Bachelor of Mechanical Engineering (Honours). The program will be known as Bachelor of Mechanical Engineering (Honours) with specialization in Nuclear Engineering. In this program, students are required to complete 130 credit hours of Mechanical Engineering required courses and technical elective courses in nuclear engineering. The technical elective courses are:

1. Introduction to Nuclear Engineering
2. Radiation Detection and Nuclear Instrumentation
3. Introduction to Reactor Physics
4. Reactor Thermal-hydraulic
5. Radiation Safety and Nuclear Waste Management

6. Nuclear Safety
7. Nuclear Security
8. Nuclear Safeguards

Students are also required to undergo their industrial training and perform their final year project at nuclear related facilities and institutions. The program structure is as shown in Appendix I.

A market survey was conducted among stakeholders in nuclear engineering and technology. The results of the survey were very encouraging and the summary of the findings are:

- 97% of the respondents think that the proposed courses would contribute to the strength of the program.
- 71% of the respondents agree that the proposed program covers all the relevant courses.
- Almost all respondents (94%) think that the length of study of the program is sufficient.
- 32% of the respondents think that the program covers the basic theory fully and 48% of them think that it covers >80% of the basic theory.
- 35% think that it covers >80% of new knowledge and the same percentage also think that it covers >50% of new knowledge.
- Almost half of the respondents (42%) think that it covers >80% of analysis criterion and almost another half (48%) think that it covers >50% of analysis criterion.
- More than half of the respondents (55%) think that it covers >50% of application criterion while only 32% think that it covers >80% of application criterion.
- Most of the respondents think that graduates of this program would be suitable working in the industry (87%) and the research and development (R&D) field (81%).
- Some of the respondents think that the appropriate income for this program's graduates is RM2,501-RM3,000 (45%) and RM3,001-RM4,000 (26%).
- The respondents think that the program would contribute to their organizations in terms of R&D activities (68%), human resource development (61%) and capacity building (42%).
- 87% of the respondents think that the program is suitable for any genders while the remaining think that it is only suitable for male.
- 52% state that their organizations have sponsored students in this field.
- 55% think that their organization would be interested in sponsoring students in this program.
- 94% think that the program would be able to produce graduates who would meet the industrial needs.
- 90% would recommend this program to friends/colleagues/relatives.

The decision for UNITEN to opt for Bachelor of Mechanical Engineering (Honours) with specialization in Nuclear Engineering is purely from the marketability of graduate point of view. It is well known fact that in a nuclear power plant, only 10% of the employees are from the nuclear engineering field. The rests of the employees are mainly from mechanical, electrical and civil engineering fields. As such, the mechanical engineering graduates with background in nuclear engineering are much more marketable. In addition, the specialization in nuclear engineering program can also be extended to students with major in electrical engineering. By taking additional courses related to thermodynamics and thermal, they are able to enroll in similar program.

The teaching faculty for the program needs to be recruited before commencing of the program. Currently, several lecturers with background in Mechanical Engineering and Physics are attending workshops and training in nuclear engineering and technology, locally and abroad. Through the MOU signed with other institutions, the university is also planning to engage teaching staff from the affiliated institutions as the teaching staff. Several lecturers will also be sent to further their studies in nuclear engineering to fulfil the required teaching staff.

5. Conclusion

Careful planning is needed to develop the nuclear engineering program at UNITEN to ensure the program meets the required standard. Cooperation with more established institutions and universities are needed for benchmarking purposes. Such cooperation is expected to enhance the quality of nuclear engineering program at UNITEN. At the same time, the marketability of the graduates is also the main concern during the planning and eventually at the implementation of the program.

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APPENDIX I:

Program Structure for Bachelor of Mechanical Engineering (Honours) with specialization in Nuclear Engineering Program at Universiti Tenaga Nasional

Semester	Code	Course	Course Type	UNITEN Credits		EAC* Equivalent Credits	
				Engineering Courses	Related Courses	Engineering Courses	Related Courses
I	MEMB113	Engineering Graphics & CAE	Core	3		3.8	
	METB113	Engineering Materials	Core	3		3.2	
	MATB113	Advanced Calculus & Analytical Geometry	Core		3		3.5
	MALB113	Bahasa Melayu I	Core		3		3.0
	CSEB 113	Principles of Programming	Core		3		4.0
II	MEFB121	Manufacturing Process Lab	Core	1		1.4	
	MEMB123	Mechanics I	Core	3		3.7	
	MATB143	Differential Equation	Core		3		3.5
	MATB253	Linear Algebra	Core		3		3.5
	ISLB112 / MORB112	Islamic Studies I / Moral Studies I	Core		2		2.0
	TECB213	Technical Communications	Core		3		3.0
III	MEFB213	Manufacturing Process	Core	3		3.2	
	MEHB213	Thermodynamics I	Core	3		3.5	
	MEMB233	Mechanics II	Core	3		3.5	
	EEEE113	Circuits Analysis I	Core	3		3.5	
	EEEE111	Electrical Measurement Lab	Core	1		1.1	
	ISLB212 / MORB212	Islamic Studies II / Moral Studies II	Core		2		2.0
IV	MEMB243	Mechanics of Materials	Core	3		3.5	
	MEMB221	Mechanics of Materials Lab	Core	1		1.1	
	MEHB223	Mechanics of Fluids I	Core	3		3.5	
	MEHB221	Thermofluid Lab	Core	1		1.5	
	MEMB263	Theory of Machines	Core	3		3.7	
	COEB223	Numerical Methods for Engineers	Core		3		3.5
	ISLB312 / MORB312	Islamic Studies III / Moral Studies III	Core		2		2.0
V	MEHB312	Thermodynamics II	Core	2		2.5	
	MEHB332	Mechanics of Fluids II	Core	2		2.5	
	MESB313	Modeling & Control of Dynamic Systems	Core	3		3.5	
	MESB333	Engineering Measurements & Lab	Core	3		3.3	
	COEB442	Engineering Economics	Core		2		2.0
	MENB401	Nuclear Policy	Core	1		1.0	
	MENB403	Introduction to Nuclear Engineering	Core	3		3.0	

VI	MEMB322	Mechanical Design Process	Core	2		2.0	
	MEMB343	Mechanical Vibrations	Core	3		3.5	
	MEMB333	Machine Design	Core	3		3.3	
	MEMB331	Machine Design & CAD Lab	Core	1		1.5	
	MASB113	Malaysian Studies	Core		3		3.0
	MENB411	Nuclear Safeguards	Core	1		1.0	
	MENB413	Radiation Detection and Nuclear Instrumentation	Core	3		3.0	
INTER SESSION	COEB314	Industrial Training	Core	4		6.0	
VII	MRPB412	Project I	Core	2		2.0	
	COEB432	Principles of Management	Core		2		2.0
	MESB443	Electro-Mechanical Systems	Core	3		3.5	
	MEHB323	Heat Transfer	Core	3		3.5	
	MEHB321	Heat Transfer & Applied Thermo. Lab	Core	1		1.5	
	MENB423	Introduction to Reactor Physics	Core	3		3.0	
	MENB433	Radiation Safety And Waste Management	Core	3		3.0	
VIII	MPRB424	Project II	Core	4		4.0	
	MEMB483	Capstone Project	Core	3		3.0	
	COEB422	Engineers in Society	Core		2		2.0
	RELB113 / CIVB113	Comparative Religion / World Civilization	Core		3		3.0
	MENB421	Nuclear Security	Core	1		1.0	
	MENB443	Nuclear Thermal Hydraulics	Core	3		3.0	
TOTAL CREDIT HOURS				91	39	103.8	42.0
TOTAL CREDIT HOURS				91 + 39 = 130		145.8	

Note:
EAC* Engineering Accreditation Council