

# DEVELOPMENT OF NUCLEAR ENGINEERING EDUCATION IN JORDAN

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**Abstract.** The establishment of a nuclear engineering education program is another step in Jordan's efforts to develop its nuclear infrastructure, and to introduce nuclear power as part of its energy mix. The program will enhance nuclear knowledge in Jordan, and will graduate qualified engineers that will help in the design, building and running of Jordan's first nuclear power plant.

The Nuclear Engineering department at Jordan University of Science and Technology (JUST), is the first and only such department/program in Jordan, Four elements will determine the success of this department and whether it will provide top quality education that will lead to realistic teaching instruction; Curriculum, Faculty, Facilities, and Students, each are discussed in this paper

## 1. Introduction

The establishment of a Nuclear Engineering program is another step in Jordan's efforts to develop its nuclear infrastructure, and to introduce nuclear power as part of its energy mix. Nuclear energy offers a promising approach to meeting Jordan's energy needs; an approach that would reduce our dependence on oil imports, create jobs, raise the standard of living, and alleviate the burden on the national budget. Nuclear energy will also be required to provide electricity to fulfill growing electrical demands, water desalination, and hydrogen production.

The Nuclear Engineering department at Jordan University of Science and Technology (JUST), is the first and only such department/program in Jordan. The university it self is a leading Jordanian institution of higher education with more than 17000 undergraduate students and 1000 graduates, including nearly 3000 international students from 41 different countries. The college of engineering is the heart of the university with nine different departments and approximately 6,000 students.

Our goal is to establish a world class department, which will enhance nuclear knowledge in Jordan, and will graduate qualified engineers that will help in the design, building and running of Jordan's first nuclear power plant. It is also our goal to serve as Jordan's leading nuclear research center.

The department is planning to start accepting students in the next academic year (2007/2008), which starts in September 2007, it will accept students both in the freshman and sophomore levels (first and second year). Thus graduating its first class in 2011, this is the period that Jordan will be in the building phase of its first nuclear power plant. Consequently nuclear knowledge transfer from nuclear suppliers and contractors of developed nations to our graduates working with them will be more realistic.

## 2. Objectives

The objectives of the Nuclear Engineering Department are to:

- (1) Educate students in the fundamental subjects necessary for a career in nuclear engineering
- (2) Prepare students for advanced education in nuclear engineering and other related fields
- (3) Educate students in the basics of nuclear technology, radiation measurement, and nuclear reactors.
- (4) Educate students in the methodology of nuclear power plants design
- (5) Train students in the basics of instrumentation use, laboratory techniques , and data acquisition, interpretation and analysis

## 3. Department Components

The building blocks of any engineering department are the Curriculum, Faculty, Facilities, and Students, these four components will determine the success of the department and whether it will provide top quality education that will lead to realistic teaching instruction

### 3.1. Curriculum

The curriculum focuses on nuclear power engineering, in particular nuclear power from fission reactors. Outstanding courses are anticipated to be offered, and the curriculum is set at the ABET standards and it is expected that the department will seek to obtain its accreditation.

The curriculum educate students in the basics of nuclear technology, radiation measurement, and power reactor engineering, furthermore it gives the student a very strong background in basic sciences and engineering.

The curriculum prepares students for careers in nuclear power, in regulatory positions with the government, or for major electric utility on the design, building, testing, and oprating of improved reactors for central-station power generation. The curriculum also prepares the graduate for work in many areas where a broad technical background is more important than specialization in a specific field.

The undergraduate currucilum consists of a minimum of 159 semester credit hours which are required to obtain the B.Sc. degree in Nuclear Engineering. These requirements are summarized in Table 1. The number and level of nuclear engineering courses offered by the department is illustrated in Figure1.

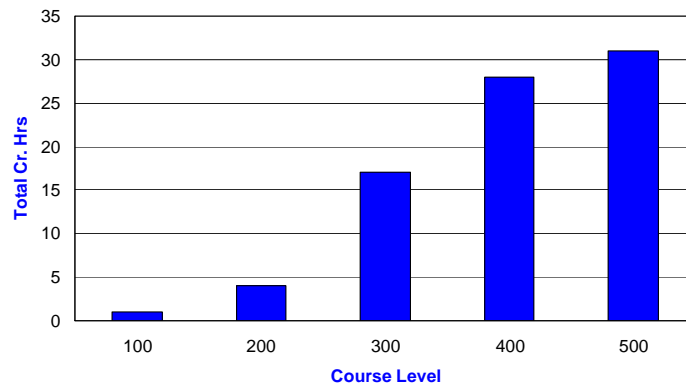


FIG. 1. Number of Nuclear Engineering Credit Hours offered by the department

Table 1. Total Credit Hours Requirement for the B.Sc. Degree in Nuclear Engineering

	Mandatory Cr. Hr.	Electives Cr. Hr.	Total Cr. Hr.
University Requirements	16	9	25
College of Engineering Requirements	32	0	32
Nuclear Engineering Department Requirements	60	14	74
Other Engineering Department Requirements	28	0	28
Total	136	23	159

### 3.2. Faculty

The quality of teaching at any institution depends to a large extent upon the quality of the faculty and academic staff. To ensure a top quality educational program, the department has to be staffed by faculty and academic staff whose graduate and undergraduate work is in nuclear engineering, or graduates with practical experience in the nuclear field, and who have gained enough nuclear knowledge, to be transferred to students.

The enormous challenge that will face the university will be staffing the department with such high caliber people. The present University salary system where all professors whether they teach music, history, or rocket science earn the same salary, is obsolete and would definitely undermine the department, and hinder its success.

Search to recruit qualified faculty members should start as soon as possible, as this method makes more economic sense than sending individuals to obtain higher degrees at the expense of the university and contract with them to comeback and teach at the University, which seems to be the preferred method of most third world counties.

Straight through school PhD graduates do not make the best faculty for a startup department like the one in Jordan, especially in the absence of nuclear facilities, industry, or basic infrastructure in Jordan. With lack of nuclear experience and the absence of supportive nuclear institutions, candidates with BSc degrees in other disciplines would remain poor in nuclear engineering since they missed all the basic and fundamental education in that field, and may not have sufficient nuclear industry or research experience.

### 3.3. Students

The program is designed to fulfill Jordan's needs for nuclear engineers and scientists, thus the students populace and department size should remain within the boundaries that serve this purpose. The university is currently preparing a pubic relation campaign, to introduce the program to future students and their families in order to attract the top high school graduates.

It is anticipated that for the next ten years, the number of students be maintained at about 100, thus accepting 20 – 25 new students every year, such a small program size would have many advantages:

- (1) Based on current market needs for Jordan; all graduates for the next ten years will have job opportunities
- (2) It will help in attracting the best students to the program
- (3) It will ensure that most graduates will be employed, even in the worst case scenario where Jordan does not go forward with its nuclear power program
- (4) The student to professors ratio would be maintained at an acceptable level

The expected number of students and full time professors for the next ten academic years is illustrated in Figure 2. The department plans to start accepting students in the next academic year (2007/2008), accepting both freshman and sophomores (first and second year) students, thus graduating its first class in 2010/2011.

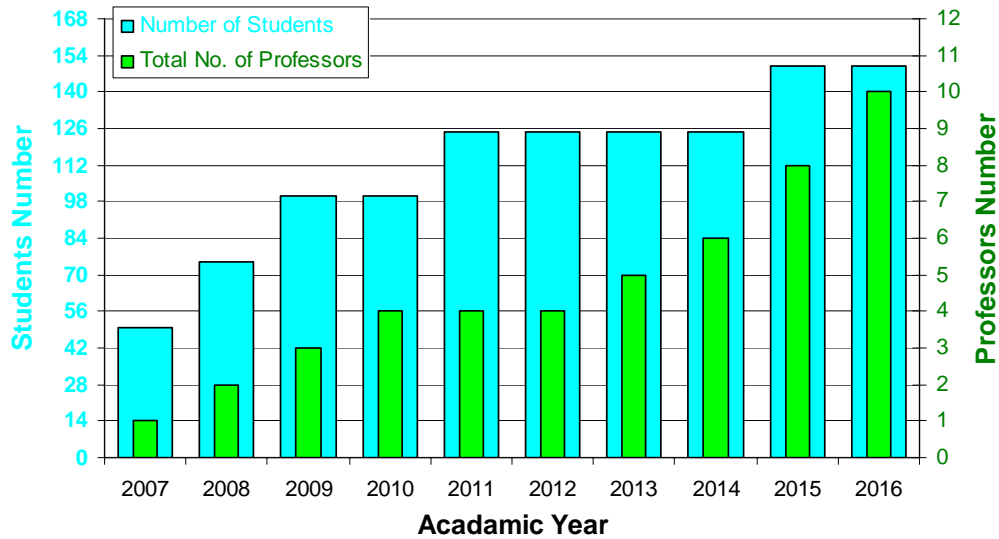


FIG. 2. Expected Number of students and Professor

### 3.4. facilities

The department will be equipped with all necessary labs and facilities for the students training, to support the curriculum, and for carrying on research. The department plans to be the leading nuclear research center in Jordan. The department is currently working on establishing the following laboratories:

- (1) Radiation Detection and Measurement Laboratory
- (2) High Speed parallel computational Laboratory
- (3) Sub-Critical Assembly Laboratory
- (4) Graphite Pile Laboratory
- (5) Environmental and Rdiological Laboratory
- (6) Thermal sciences Laboratory
- (7) Research and Training Reactor (RTR).

#### 4. Study Plan

A suggested study plan for obtaining the BSc. Degree in Nuclear Engineering is shown in the tables 2 through 5

Table 2. First year study plan

First Semester			Second Semester		
Course	Course Name	Cr Hr	Course	Course Name	Cr Hr
Arab 101	Arabic Language I	3	CIS 100	Computer Skills	3
Math 101	Calculus I	3	Math 102	Calculus II	3
Phys 101	General Physics I	3	Phys 102	General Physics II	3
Chem 101	General Chemistry I	3	Phys 107	General Physics Lab	1
Engl 111	English Language I	3	Chem 102	General Chemistry II	3
NE 101	Basics of Nucl. Engineering	1	Chem 107	General Chemistry Lab	1
Arab 103	Arabic Language Lab	1	Engl 112	English Language II	3
<b>TOTAL</b>		<b>17</b>	<b>TOTAL</b>		<b>17</b>

Table 3. Second year study plan

Third Semester			Fourth Semester		
Course #	Course Name	Cr Hr	Course #	Course Name	Cr Hr
CIS 115	Computer Language C++	3	IE 341	Engineering Economy	2
EE 212	Electrical Circuits	3	EE 200	Communication Skills for Engineers	2
EE 316	Circuits Lab *	1	MS100	Military Science	3
Math 203	Ordinary Differential	3	NE 202	Fundamentals of NE	3
Math 201	Intermediate Analysis	3	ME 220	Engineering Drawing	1
NE 201	Ethics & the Development of Nuclear Technology	1	EE 302	Numerical Methods	3
ME 215	Engineering Mechanics	3	IE 361	Engineering Materials	3
<b>TOTAL</b>		<b>17</b>			<b>17</b>

Table 4. Third year study plan

Fifth Semester			Sixth Semester		
Course #	Course Name	Cr Hr	Course #	Course Name	Cr Hr
NE 301	Introduction to Nuclear Engineering	3	NE 322	Radiation Protection & Dosimetry	3
NE 311	Ionizing Radiation Detection and Measurement	3	NE 314	Radiation Detection and Measurement Lab	1
NE 313	Nuclear Instruments Lab	1	NE 330	Nuclear Reactors thermal hydraulics	3
ChE 341	Thermodynamics I	3	NE 340	Nuclear Reactor Theory	3
CHE 343	Fluid Mechanics	3	ME 301	Applied Mathematics for Engineers I	2
UE	University Electives	3	ChE 346	Heat Transfer	3
			ChE 447	Heat Transfer Lab 1*	1
	TOTAL	16	TOTAL		16

Table 5. Fourth year study plan

Seventh Semester			Eight Semester		
Course No.	Course Name	Cr Hr	Course No.	Course Name	Cr Hr
NE 471	Radiation Interactions and Shielding Design	3	ChE 400	Professional Ethics for Engineers	1
NE 441	Nuclear Reactor Analysis	3	NE 448	Nuclear Reactor Engineering Experiments	3
NE 443	Neutrons interactions Lab	1	NE 452	Nuclear I&C	3
NE 451	Nuclear Power Plant Systems and Operations I	3	NE 460	Fuel Cycle and Waste Management	3
NE 465	Nuclear Material	3	NE 472	Monte Carlo Simulation and Reactor Modeling	3
UE	University electives	3	NE 490	Nuclear Engineering Training	3
			UE	University electives	3
	TOTAL	16	TOTAL		16

Table 6. Fifth year study plan

Ninth Semester			Tenth Semester		
Course No.	Course Name	Cr Hr	Course No.	Course Name	Cr Hr
NE 521	Reactor Safety and PRA	3	NE 592	Senior Project II	3
NE 571	In Core Fuel Management	3	NE	Technical Elective	3
NE 591	Senior Project I	1	NE	Technical Elective	3
NE	Technical Elective	3	NE	Technical Elective	3
NE	Technical Elective	2			
<b>TOTAL</b>		<b>12</b>			<b>12</b>

#### REFERENCES

- [1] ABET Criteria for Accrediting Engineering Programs, 2006, USA
- [2] Report of the Nuclear Energy Research Advisory Committee Nuclear Power Engineering Curriculum Task Force, OSU, April 7, 2004, USA
- [3] International Conference on Nuclear Knowledge Management: Human Resource Development September 9, 2004, IAEA
- [4] Z. Kodah & N. Xoubi, Draft Report on the establishment of a nuclear engineering program, Jordan Atomic Energy Commission, December, 2006, JAEC