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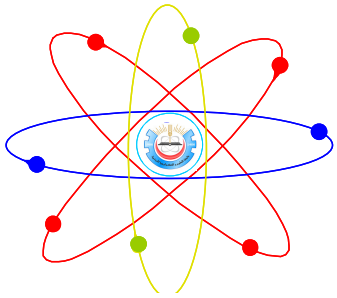
Jordan University of
Science & Technology

Faculty of Engineering

Nuclear Engineering Department



Undergraduate Curriculum for the B.Sc. Degree in Nuclear Engineering

2007 / 2008

Vision

Towards excellence in nuclear engineering education, research, and effective utilization of nuclear energy.

Mission

The mission of the Department of Nuclear Engineering is to be Jordan's center of excellence in nuclear engineering education and research, and to lead Jordan's effort to develop its nuclear infrastructure, and to introduce nuclear power as part of its energy mix.

The mission of the undergraduate program is to graduate qualified engineers who are capable of contributing valuable engineering skills and knowledge toward the design, building and running of Jordan's first nuclear power plant.

Department 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 on the basics of nuclear instrumentation use, laboratory techniques, and data acquisition, interpretation and analysis.
6. Promote nuclear research and studies, which address local, regional and international problems.
7. Disseminate nuclear information, to advance public awareness, and enhance nuclear knowledge in Jordan.

BSc Program Learning Outcomes

To achieve its key objectives, the Nuclear Engineering program has designed its curriculum to ensure that graduating students achieve the following eleven learning outcomes:

1. The ability to apply knowledge of mathematics, science and engineering to the analysis of nuclear and other engineering systems. [a]
2. The ability to design and perform nuclear and radiation experiments, gather, analyze and interpret the results. [b]
3. The ability to design integrated nuclear systems, components, or processes applicable to nuclear engineering and radiological sciences, including realistic constraints. [c]
4. The ability to learn and work independently, and to practice leadership and function in multidisciplinary teams. [d]
5. The ability to identify and formulate nuclear engineering problems, and develop practical solutions. [e]
6. An understanding of professional and ethical responsibility of a nuclear engineer. [f]
7. The ability for effective oral, graphic and written communication. [g]
8. A broad education necessary to understand the global impact of nuclear energy, and its effect in social, economical, safety and environmental context. [h]
9. A recognition of the importance of, and an ability to engage in life-long learning. [i]
10. Stay aware of latest technologies and advances in disciplines related to Nuclear Engineering and engineering in general utilizing latest resources of knowledge. [j]
11. The ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. [k]

* *Letters in brackets refer to ABET criteria*

Undergraduate Curriculum

Undergraduate Degree Plan

Course Coding (Numbering)

A five to six-digit number, coded as follows, is used to designate courses:

Department		Level/Year	Field	Sequence
0	0	0	0	0
A	B	X	Y	Z

The Department codes are as follows:

Code	Department
AE	Architectural Engineering
CE	Civil Engineering
ME	Mechanical Engineering
EE	Electrical Engineering

Code	Department
IE	Industrial Engineering
ChE	Chemical Engineering
BME	Biomedical Engineering
NE	**Nuclear Engineering**

Therefore, courses in Nuclear Engineering will have codes of the form **NE** XYZ, where the coding of X, Y and Z will be described later.

The following presents the courses (and their prerequisite /co-requisite) within each of the requirements needed to obtain a B.Sc. in Nuclear Engineering.

B.Sc. Degree (159 Semester Credits)

A Bachelor of Science degree in Nuclear Engineering at JUST is awarded in accordance with the Statute stated in the JUST regulations for B.Sc. awarding issued by the Deans' council based on the 1987 law for awarding scientific degrees and certifications at JUST, and after the successful completion of 159 credit hours, distributed as indicated in Tables 1 and 2.

Table 1. Distribution of Credit hours

Classification		Credit Hours		
		Compulsory	Elective	Total
University Requirements		16	9	25
Faculty Requirements		32	-	32
Department Requirements	**Compulsory**	96	-	96
	Electives	-	6	6
	Total =	**144**	**15**	**159**

Table 2. Courses Classification

Source of Courses		Credit Hours	Percentage
Humanities	Lecture	24	15.1%
	Lab	1	0.6%
Basic Sciences	Lecture	30	18.9%
	Lab	2	1.3%
General Engineering Sciences	Lecture	25	15.7%
	Lab	4	2.5%
Nuclear Engineering Sciences	Lecture	63	39.6%
	Lab	10	6.3%
Total	Lecture	142	89.3%
	Lab	17	10.7%

University Requirements (25 Credit Hours)

Compulsory: (16 Credit Hours)

Table 3. University Compulsory Courses

Course No.	Course Title	Cr. Hr.	Lecture	Lab.	Prerequisite or *Corequisite
Arb 101	Arabic Language	3	3		
Arb 103	Applied Arabic Language Studies	1		3	
Eng 111 (1)	English Language	3	3		Pass Eng 99
Eng 112	Communication Skills II	3	3		Eng 111
CIS 100 (2)	Computer Skills	3	3		
MS100 (3)	Military Sciences	3	3		
	Total	**16**			

1) A student who passes the English Language Placement Test with a grade > 80% is exempted from both Eng 099 and Eng. 111, while a student who passes the English Placement Test with a grade between 50% and 80% is exempted from Eng 099 only.
2) A student who passes the Computer Skills Placement Test with a grade > 50% is exempted from CIS 100.
3) This course is required from Jordanian students only; graded on Pass/Fail basis. Students graduating from Royal Military faculty and military candidates school and equivalent institutes are exempted from taking this course: Non-Jordanian Arabic Speaking students are required to take a substitute for this course from the elective courses and in this case the grade of this course is included in their grade point average (GPA).

Notice: All non Arabic Speaking foreign students in the University are required to study two courses in Arabic language as shown below:

Table 4. Courses for non Arabic Speaking Students

Course No.	Course Title	Cr. Hr.	Lecture	Lab.	Prerequisite or Corequisite
Arb101A	Fundamentals of Arabic Language (for non Arabic speaking students as a substitute for the course Arb101 Arabic Language)	3	3		
Arb103A	Fundamentals of Arabic Language Lab for non Arabic speaking students as a substitute for the course Arb103 Applied Arabic Language Studies)	1		3	

Elective: (9 Credit Hours)

The university elective courses are three courses with a total of 9 Cr. Table 5 lists these courses.

Table 5. University Elective Courses for Engineering Students

Course No.	Course title	Cr. Hr.	Lecture	Lab.	Prerequisite or Corequisit
ES 103	Environment Protection (for non Environment Sciences students)	3	3	0	
PH 200	First Aid and Emergency Procedure (for non Medicine, non Nursing, and non Midwifery students)	3	3	0	
PH 104	Community Health and Nutrition (for non Medicine, non Nursing, and non Midwifery students)	3	3	0	
PHAR 104	Drugs and Medical Plants (for non Medicine, and non Pharmacy students))	3	3	0	
NUR 100	Health Promotion (for non Medicine, non Nursing, and non Midwifery students)	3	3	0	
ADS 100	Oral and Dental Health (for non Dentistry and non Dentistry Sciences students)	3	3	0	
PP 200	Home Gardens (for non Agriculture students)	3	3	0	
PP 201	Bee Keeping (for non Agriculture students)	3	3	0	
VM 211	Animal Health (for non Veterinary Medicine and non Agriculture students)	3	3	0	
VM 212	Pet Animal Care (for non VM and Agriculture students)	3	3	0	
HSS 112	Hadith Shareef	3	3	0	
HSS 113	Aqideh	3	3	0	
HS 114	Fekeh	3	3	0	
HSS 115	Islam and Recent Problems	3	3	0	
HSS 116	Islamic Economy System	3	3	0	
HSS 121	Principles of Sociology	3	3	0	
HSS 126	Principles of Psychology	3	3	0	
HSS 127	Educational Technology	3	3	0	
HSS 128	National Education	3	3	0	
HSS 131	Islamic Civilization	3	3	0	
HSS 132	The History of the City of Jerusalem	3	3	0	
HSS 133	Civilization and Recent Cultures	3	3	0	
HSS 141	Introduction to Economics (for non CIS students)	3	3	0	
HSS 142	Library and Information Research	3	3	0	
HSS 151	Introduction to Management Sciences (for non CIS students)	3	3	0	
HSS 161	Contemporary Problems	3	3	0	
HSS 166	Man and Science	3	3	0	
HSS 182	Studies on Women	3	3	0	
HSS 250	Music History (in English)	3	3	0	
HSS 211	Introduction to Sociology in English	3	3	0	

HSS 212	Arab Society	3	3	0	
HSS 213	Individual and Society	3	3	0	
HSS 216	International Global Issues	3	3	0	
HSS 221	Introduction to Psychology in English	3	3	0	
HSS 222	Creativity and Problems Solving	3	3	0	
HSS 224	Leader ship and Communication Skills	3	3	0	
HSS 241	Economy in the Third World	3	3	0	
HSS 242	Information and Research	3	3	0	
HSS 429	Behavioral Science and Dealing with Children	3	3	0	
PT 100	Health and Life Styles (for non physical therapy students)	3	3	0	
ME 211	Fundamentals of Automobile Engineering (for non ME students)	3	3	0	
NR 200	Natural Resources and Human Being	3	3	0	
NF 177	Food Preservation (in English)	3	3	0	

Faculty Requirements: (32 Credit Hours)

The Faculty of Engineering requirements consist of 32 Credit Hours distributed as follows:

Table 6. Faculty of Engineering Compulsory Courses

Course No.	Course Title	Cr. hr.	Lecture	Lab.	Prerequisite or Corequisite
Math101	Calculus I	3	3		----
Math 102	Calculus II	3	3		Math 101
Math 201	Intermediate Analysis	3	3		Math 102
Math 203	Ordinary Differential Equations	3	3		Math 102
Phys 101	General Physics I	3	3		----
Phys 102	General Physics II	3	3		Phys 101
Phys 107	General Physics Lab	1		3	Co Phys 102
Chem 101	General Chemistry I	3	3		----
Chem 102	General Chemistry II	3	3		Chem 101
Chem 107	General Chemistry Lab	1		3	Co Chem 102
CS 115	Programming in C++ Language	3	3		CIS 100
EE 202	Communication Skills for Engineers	2	2		2nd Year Standing
ChE 400	Professional Ethics for Engineers	1	1		90 credits
	Total	**32**	**32**		

Department Requirements: (102 Credit Hours)

Course Numbering

The nuclear engineering courses are tabled and numbered in such a manner to recognize each course regarding its subject area, level, and offering semester. The symbol NE denotes Nuclear Engineering each number is made of 3 digits, first digit denotes the level of the course according to student's study plan as follows:

First Digit	Level of Course
1	First year
2	Second year
3	Third year
4	Fourth year
5	Fifth year.

The second digit denotes the course field subject as follows:

Second Number	Specialization
0	Basics of nuclear engineering
1	Radiation and its applications
2	Safety and radiation protection
3	Thermal hydraulic and heat transfer
4	Reactor engineering and neutronics
5	Nuclear system analyses and control
6	Nuclear materials
7	Modeling and design.
8	Special topics
9	Applied engineering applications, graduation project.

Example:

	NE 532		
NE	5	6	2
Department	Level (Fifth year)	Field (Nuclear materials)	Sequence (Second semester)

Department Compulsory Courses: (93 Credit Hours)

Department compulsory courses are 96 credit hours distributed in Tables 7 and 8.

Table 7: Nuclear Engineering compulsory courses (64 credit hours)

Course No.	Course Title	Cr. hr.	Lecture	Lab.	Prerequisite or Corequisite
NE 101	Basics of Nuclear Engineering & Technology	1	1		----
NE 201	Ethics & the Development of Nuclear Technology	1	1		----
NE 202	Fundamentals of Nuclear Science	3	3		Phys 102
NE 272	Programming for Nuclear Engineers	3	3		CS 115
NE 301	Introduction to Nuclear Engineering	3	3		NE 202
NE 311	Ionizing Radiation Detection & Measurement	3	3		NE 202
NE 313	Radiation Detection and Measurement Lab I	1		3	Co NE 311
NE 314	Radiation Detection and Measurement Lab II	1		3	NE 313
NE 322	Radiation Protection and Dosimetery	3	2	3	Co NE 311
NE 330	Nuclear Reactors Thermal Hydraulics	3	3		ChE 340, ME 451*
NE 340	Nuclear Reactors Theory	3	3		NE 301
NE 441	Nuclear Reactors Analysis	3	3		NE 340, NE 330
NE 443	Neutron Interactions Laboratory	1		3	NE 314
NE 448	Nuclear Reactor Lab	3	1	6	NE 441
NE 451	Nuclear Power Plant Systems and Operations I	3	3		NE 340, NE 330
NE 452	Nuclear Instrumentation & Control	3	3		NE 340, EE 212
NE 460	Fuel Cycle and Waste Management	3	3		NE 441
NE 465	Nuclear Reactor Material	3	3		NE 340 & IE 361
NE 471	Radiation Interactions and Shielding Design	3	3		NE 330, NE 314
NE 472	Modeling and Simulation of Nuclear Reactors	3	2	3	NE 441
NE 481	Nuclear Engineering Seminar	1	--	--	Completion of 90 Cr
NE 490	Engineering Training	3	--	--	Completion of 117 Cr
NE 521	Nuclear Reactor Safety	3	3		NE 451
NE 571	In Core Fuel Management	3	2	3	NE 441, NE 472
NE 591	Graduation Project (1)	1			Completion of 114 Cr
NE 592	Graduation Project (2)	3			NE 591
	Total	**64**			

Table 8. Department compulsory courses from other engineering departments (32 credit hours)

Course No.	Course Title	Cr. hr.	Lecture	Lab.	Prerequisite or Corequisite
ME 101	Engineering Workshops	2	1	3	---
ME 200	Engineering Drawing A	1	0	3	CIS 100
EE 240	Introduction to Linear Systems	3	3		Math 201, CS 115
ME 343	Fluid Mechanics	3	3		Phys 101, Math 203
ME 451	Heat Transfer 1	3	3		Math 203 , ME 343
ME 445	Thermo Fluid Lab.	1		3	Co ME 451
EE 212	Electric Circuits Analysis	3	3		Phys 102, Co Math 203
EE 213	Electric Circuits Lab	1		3	EE 212
EE 305	Numerical Methods for Engineers	3	3		Math 203, CS 115
IE 211	Mechanics of Materials	3	3		Phys 101
IE 341	Engineering Economy	2	2		Math 201
IE 361	Engineering Materials	3	3		ME 101, Co IE 211
IE 365	Engineering Materials Lab	1	0	3	IE 361
ChE 340	Thermodynamics	3	3		Math 203
	Total	**32**			

Department Technical Electives: (6 Credit Hours)

The student is advised to select courses (6 Credit Hours) from the following list to help in the work of his graduation project.

Table 9. Department technical elective courses

Course No.	Course Title	Cr. hr.	Lecture	Lab.	Prerequisite or *Corequisite
NE 500	Economic & Environmental Aspects of Nuclear Energy	3	3		NE 451
NE 501	Non Power Applications of Nuclear Energy	3	3		NE 314 & 340
NE 525	Environmental Radioactivity	3	2	3	NE 314 & 322
NE 552	Nuclear Power Plant Systems and Operations II	3	3		NE 451
NE 579	Nuclear Reactor Design Methodology	3	3		NE 472
NE 560	Radiochemistry	3	2	3	NE 314 & IE 361
NE 581	Special Topics in Nuclear Engineering	3			Department Approval
ME 501	Water Desalination	3	3		ME 451
	Total	**24**			

Course Description

NE 101: Basics of Nuclear Engineering & Technology (1, 0) 1Cr

What is nuclear engineering, what do nuclear engineers do, uses of nuclear energy, radiation around us, nuclear energy and its roll in society.

Pre: None

NE 201: Ethics & the Development of Nuclear Technology (1, 0) 1Cr

Ethical issues arising from the development of nuclear technology, and our ability to address, deal, and resolve them. Cases studies will be emphasized.

Pre: None

NE 202: Fundamentals of Nuclear Science (3, 0) 3Cr

Atomic and nuclear physics, atomic models, relativity, x-rays, types of nuclear reactors, other topics related to nuclear sciences and technology.

Pre: Phys 102,

NE 272: Programming for Nuclear Engineers (3,0) 3Cr.

This course is designed to keep the nuclear engineering student on the cutting edge of operating systems and programming languages used in nuclear codes. The course will introduce the students to Fortran Language, Unix, parallel computation, and other languages deemed necessary for codes coupling. A set of laboratory experiments will provide hands-on experience in related topics.

Pre: CS 115

NE301: Introduction to Nuclear Engineering (3, 0) 3Cr

Basic radioactivity, nuclear and neutron physics as applied to nuclear engineering. Introduction to neutron diffusion theory, neutron moderation, conditions for criticality of nuclear of nuclear reactors.

Pre: NE 202

NE 311: Ionizing Radiation Detection and Measurement (3, 0) 3Cr

Sources, interaction of radiation with matter. Behavior of various nuclear radiation detectors. Properties of radioisotopes useful to industry are considered and evaluated from engineering point of view.

Pre: NE 202

NE 313: Radiation Detection and Measurement Lab I (0, 3) 1Cr

Nuclear electronics, radiation detection and counting instrumentation, counting statistics, radiation survey, half-life and decay schemes.

Pre: Co-NE 311

NE 314: Radiation Detection and Measurement Lab II (0, 3) 1Cr.

Gamma, alpha, and beta detectors, gamma spectroscopy, coincidence counting, proportional counters, HPGe detectors, spectrum analysis, scintillation detectors for charged particle.

Pre: NE 311

NE 322: Radiation Protection and Dosimetery (2, 3) 3Cr

Principles of radiation protection, biological effects of radiation, radiation risk assessment, external and internal dosimetery.

Pre: Co-NE 311

NE 330: Nuclear Reactors Thermal Hydraulics (3, 0) 3Cr

Reactor heat generation and removal, steady- and unsteady state conduction in reactor elements; single phase, two-phase, cooling, core thermal design.

Pre: ChE 340, C0-ME 451

NE 340: Nuclear Reactors Theory (3, 0) 3Cr

An introduction to neutron diffusion theory, neutron moderation, conditions for criticality of nuclear reactors. Four factor formula, six factor formula, neutrons economy, infinite reactor, and boundary conditions

Pre: NE 301

NE 441: Nuclear Reactors Analysis (3, 0) 3Cr

The Multi-group diffusion theory, diffusion method, heterogeneous reactors, reactor kinetics, changes in reactivity, the neutronics behavior of fission reactors, thermal neutron spectra, fine group whole spectrum calculations and coarse group constant generation.

Pre: NE 330, 340

NE 443: Neutrons Interactions Laboratory (0, 3) 1Cr

Neutrons interactions experiments, subcritical assembly, graphite pile, neutron moderation, neutron activation analysis.

Pre: NE 314

NE 448: Nuclear Reactor Lab (1, 6) 3Cr

Experimental measurements of basic nuclear reactor parameters, flux measurement, reactor period, approach to critical. Reactor operation and reactor safety.

Pre: NE 441

NE 451: Nuclear Power Plant Systems and Operations I (3, 0) 3Cr.

Description of light water power plants systems, NSSS system, secondary systems, reactor safety systems, plant layout, steam cycles, electrical, mechanical, and nuclear system components, practical aspects of NPP system operation

Pre: NE 330, NE 340

NE 452: Nuclear Instrumentation & Control (3, 0) 3Cr.

Nuclear digital I&C (Instrumentation & Control) related to the systems which receive thousands of plant field signals and process them to control the nuclear plants in normal and abnormal conditions.

Pre: NE 340, EE 212

NE 460: Fuel Cycle and Waste Management (3, 0) 3Cr.

The front and back end of the fuel cycle, management of radioactive, hazardous and mixed waste generated by all segments of the nuclear fuel cycle and users of radioisotopes; includes treatment, storage and disposal technologies.

Pre: NE 441

NE 465: Nuclear Reactor Materials (3, 0) 3Cr.

Nuclear reactor materials, fuel element, fission gas swelling, void swelling, cladding, moderators, materials thermal properties, chemical behavior and radiation damage.

Pre: NE 340 & IE 311

NE 471: Radiation Interactions and Shielding Design (3, 0) 3Cr.

Basic principles of radiation interactions and transport, especially as related to the design of radiation shields. Radiation sources, nuclear reactions, radiation transport, photon interactions, dosimetry, buildup factors and fast neutron shielding.

Pre: NE330 and 314

NE 472: Modeling and Simulation of Nuclear Reactors (2, 3) 3Cr

Analysis of radiation transport problems by Monte Carlo method, use of MCNP code system, reactor modeling and simulation.

Pre: NE 441

NE 481: Nuclear Engineering Seminar (1, 0) 1 Cr.

Seminar of nuclear engineering issues, each lecture is presented by a faculty member, or invited local and international nuclear engineers, researchers, policy makers, and industry people

Pre: Completion of 90 Cr

NE 490: Engineering Training (0, 9) 3Cr.

Training at a nuclear or radiation facility, that is involved in the design or utilization of nuclear energy

Pre: Completion of 117 Cr

NE 500: Economic & Environmental Aspects of Nuclear Energy (3, 0) 3Cr.

Economics of nuclear power, economical and environmental impact, the nuclear fuel cycle. Impact on design, plant sitting, regulation, and international laws.

Pre: NE 451

NE 501: Non-Power Applications of Nuclear Energy (3, 0) 3Cr.

Applications of nuclear energy in space exploration, agricultural, medical, industrial, and biomedical, and other related non-power generation fields.

Pre: NE 314, NE 340

NE 521: Nuclear Reactor Safety (3, 0) 3Cr.

Nuclear reactor safety and probabilistic risk assessment**.** Analysis and evaluation applied to reactor design for accident prevention and mitigation; protective systems and their reliability, containment design, emergency cooling requirements, reactivity excursions and the atmospheric dispersion of radioactive material.

Pre: NE 451

NE 525: Environmental Radioactivity (2, 3) 3Cr.

Radioactivity in the environment, traces in air, water, soil. Pathways of contamination.

Pre: NE 314 & NE 322

NE 552: Nuclear Power Plant Systems and Operations II (3, 0) 3Cr.

LW power plant systems requirements and design parameters. Systems required for steam production, cooling of core in all modes of operation, and safe and efficient plant operation. NPP blue prints and systems components recognition, and processes flow. Safety analysis report.

Pre: NE 451

NE 560: Radiochemistry (2, 3) 3Cr

The chemistry of radioactive material, transuranic elements, the effect of radiation on the chemical properties of material.

Pre: NE 314, IE 361

NE 571: In core Fuel Management (2, 3) 3Cr.

In core fuel management, and optimization of fuel cycle loading and design, reactor vender's codes.

Pre: NE 441, NE 472

NE 579: Nuclear Reactor Design Methodology (3, 0) 3Cr.

Application of reactor theory and other engineering disciplines in fundamental and practical design of nuclear reactor systems for power applications. Use of computer codes in calculations, design and optimization.

Pre: NE 472

NE 581: Special Topics in Nuclear Engineering 3 Cr.

Special nuclear engineering issues that is not covered in the current curriculum, problems related to recent developments and practice, as well as related current literature.

Pre: Instructor Approval

NE 591: Graduation Project I. 1Cr.

Nuclear Engineering Graduation Design.

Completion of 114 Cr

NE 592: Graduation Project II. 3Cr.

Nuclear Engineering Graduation Design. Meeting with instructor, Final Report, and presentation.

Pre: NE 591