UNIVERSITY OF TRIPOLI
FACULTY OF ENGINEERING

NUCLEAR ENGINEERING DEPARTMENT

Graduate Program

Brief History

Nuclear Engineering, as is well-known, is directly concerned with the release, control and utilization of all energy types produced from nuclear sources and its environmental impact. Today, the diversity of nuclear energy allows a wide variety of applications from the exploration of outer space and the powering of human heart pace-makers to the generation of electricity. With the limited supply of fossil fuels and the growing concern about their environmental effect, the need for nuclear power to produce the large amounts of energy demanded by our society is becoming more and more pressing. The department of nuclear engineering is playing a vital role in educating the technical manpower required to meet this need.

Nuclear Engineering department (NE) was established in 1978 as one of departments in the Faculty of Nuclear and Electronic Engineering. After few years the Department joins the Faculty of Engineering with the same name. Since1978, the Department offers Bachelor degree in Nuclear Engineering. In 1993 the Department initiated a graduate program that offers advanced courses and research work to obtain a Master degree in Nuclear Engineering. The University of Tripoli's Department of Nuclear Engineering is the only nuclear engineering program in Libya. The Department offers Master degree in three branches**:** Nuclear reactor engineering; applications of radiation and medical radiation physics depending on the interest and career objectives of the student. The areas of employment are: Industry, government and universities, where the Nuclear Engineers may be employed different fields, such as; reactor analysis, radioisotope applications, computer applications, energy transfer, radiation protection, safety analysis, instrumentation and control.

Most of the computer codes on nuclear calculations, radiation transport and shielding, necessary for this graduate program are available at the department and at the Tajura Nuclear Research Center (TNRC). Some of the facilities which are necessary for this program are already available at the Department such as advanced radiation detection and measurements laboratory, health physics lab, simulation lab, thermal-hydraulics lab. However, the major part of it is expected to be at the Nuclear Research Center. These will

include a 10 MW research reactor, a zero power training critical assembly, a Cobalt-60 source, several small digital computers, hot cells for handling radioactive materials, a complete nuclear instrumentation laboratory facilities for analysing environmental samples by nuclear techniques, nuclear radiography, radiochemical laboratories, etc.

The program of Medical radiation physics is jointly conducted with the Faculty of Medicine of the University of Tripoli and the Tripoli Medical Centre (TMC). This program applies the concepts and principles of physics to the diagnosis and treatment of human diseases.

This program is designed to offer an advanced training in medical radiation physics, with the aim of qualifying personnel capable of working at radiotherapy and nuclear medicine departments in specialized medical centers. Medical Physics encompasses four fields: Imaging, Nuclear Medicine, Radiation Oncology and Medical Health Physics. The TMC radiation therapy and the nuclear medicine department facilities including Cobalt-60 Unit, linear accelerators (Linac) and two gamma cameras and the associated instrumentation are available for experiments and research projects.

Vision

Through its facilities and advanced computer resources, the Department integrates education and research, giving our undergraduate and graduate students opportunities to solve real- problems in classroom, field and laboratory settings. In other words, provide professional development program that enables students to gain the necessary skills and insights in the nuclear field and, hence, assume their careers in confidence.

Mission

The mission of the Nuclear Engineering program at the Faculty of Engineering – University of Tripoli is to produce nuclear engineers who will make significant contributions to the world enterprise. The specific focus of our mission is to prepare graduates to excel in a wide range of careers in nuclear power reactors, the nuclear radiation, the nuclear fuel cycle, and other applications of nuclear technology. In other words, to offer advanced knowledge and professional continuing education by focusing on academic and practical aspects of peaceful uses and applications of nuclear energy and radiation in the areas of power generation and water desalination as well as industrial, medical and environmental application of nuclear radiation.

Programs

The graduate program in the Nuclear Engineering Department offers M.Sc. degree in the following:
Program I: Nuclear Reactor Engineering.

Program I

PROGRAM	*Nuclear Reactor Engineering*
DEGREE	*M.Sc.*
OBJECTIVES	The graduate program aims to provide the postgraduate student with advanced knowledge in the field of nuclear engineering. Courses are designed to cover most recent trends in the nuclear applications. 1- Our graduates who will be active in the nuclear industry or related fields, making contributions to its advancement, either in industry, research, or academics. 2- Our graduates will have a record of accomplishment in the nuclear industry. 3- Our graduates will engage in lifelong learning, keeping abreast of advancements in their fields.

Code	***Title***	***Credits***	***Hours***	***ECTS***
Faculty Requirements (3 credits)				
GE604	Advanced Engineering Mathematics **	3	4	8
GE609	Advanced Numerical Methods for Engineering	3	4	8
Department Requirements (12 credits)				
NE612	Advanced Reactor Theory	3	4	8
NE621	Advanced Nuclear Reactor Thermal-hydraulics	3	4	8
NE651	Nuclear Reactor Core Design and Analysis I	3	4	8
NE671	Nuclear Reactor Dynamics and Control	3	4	8
Elective courses (10 credits)				
NE619	Computational Methods in Reactor System	3	4	8
NE620	Advanced Heat Transfer	3	4	8
NE631	Nuclear Radiation Shielding	3	4	8
NE632	Advanced Nuclear Power Reactor Safety	3	4	8
NE633	Nuclear Security & Safeguards	3	4	8
NE652	Nuclear Reactor Core Design And analysis II	3	4	8
NE653	Nuclear Fuel Management	3	4	8
NE670	Fast Reactor Physics	3	4	8
NE672	Modelling and Simulation of Plant Dynamics	3	4	8
NE623	Two Phase Flow	3	4	8

NE697	Special Topics	3	4	8
NE698	Graduate Seminar **	1	2	10
Thesis (6 Credits)				
NE699	M. Sc. Thesis	6	0	50
Total		**31**	**0**	**124**

Description of the Graduate Courses:

- *Faculty General Courses*

GE604 Advanced Engineering Mathematics *(3 Credits - 4 Hours)*

Review of ordinary differential equations; linear differential equation of the first order; linear differential equations with constant coefficients; particular solutions by variations of parameters. Power series solutions; method of Frobenius; Legendre's equation; Fourier-Legendre Series; Bessel's equation; modified Bessel equation. Fourier methods; Fourier series; Sturm-Liouville theory; Fourier integral; Fourier transformation. Partial differential equations; heat conduction equation; separation of variables; waves and vibrations in strings; wave equation; D'Alembert's solution; longitudinal vibrations in an elastic rod; two dimensional stress systems; solution of Navier's equations by the application of Fourier transforms; Laplace equation.

GE609 Numerical Methods in Engineering (*3 Credits - 4 Hours)*

Interpolation; Linear interpolation, Lagrange and Aitkin's interpolating polynomials, Difference calculus, Newton forward and backward difference formula, curve fittings, least square approximations, Fitting nonlinear curves, Cubic spline, Chebyshev polynomials, Approximation with rational function ordinary differential equations, Analytical and computer-aided solutions, Boundary conditions, Taylor series method.

- *Department Courses*

I. Nuclear Reactor Engineering program courses

NE612 Advanced Reactor Theory *(3 Credits - 4 Hours)*

Neutron transport equation and its solution by spherical harmonics and Fourier transforms and SN methods, Adjoint function, Numerical solution of multi-group equations The Monte Carlo Method, Computer codes for reactor calculations.

NE619 Computational Methods in Reactor systems *(3 Credits - 4 Hours)*

Computational methods employed in radiation transport problems, fluid and heat flow systems with the assistance of numerical software. Matrix inversion methods and finite difference solutions.

NE620 Advanced Heat Transfer *(3 Credits - 4 Hours)*

This course mainly comprises two parts: thermal conduction and convection. The thermal conduction part covers conduction formulations, analytical methods, and numerical technique to solve the multidimensional steady-state and transient conduction problems. The convection part covers the fundamental concepts of convection, governing equations, boundary layers and analytical solutions for external and internal flows, natural convection, boiling and condensation heat transfer.

NE621 Advanced Reactor Thermal hydraulics *(3 Credits - 4 Hours)*

Mechanisms of heat transfer, Differential and integral formulation of conduction in solids with special emphasis on systems involving energy generation, Approximate (numerical) and exact solution procedures, Forced convection heat transfer in single phase coolants, Heat transfer with change in phase, Two phase flow and boiling heat transfer, Core thermal design Turbulent via dimensional analysis (coupled with experimental results).

NE631 Nuclear Reactor Shielding *(3 Credits - 4 Hours)*

Interaction of radiation with matter, Radiation transport: kernel techniques, removal diffusion method (the spinney method), Monte-Carlo method, Shield attenuation calculations, shield heating, Air transport, Shield materials, and shield optimization, Experimental shielding, Shield design.

NE632 Nuclear Reactor Safety *(3 Credits - 4 Hours)*

Probabilistic safety and risk analysis, Analysis of reactor safety, Safety Analysis report and LOCA, integrating of safety analysis into operational requirements, Releases of radioactive materials. Nuclear security and safeguards.

NE633 Nuclear Security and safeguards *(3 Credits - 4 Hours)*

Introduction to Nuclear Security, Interrelationships between Safety, Security and Safeguards, Basic elements of Nuclear Security, Planning Nuclear Security of Nuclear/Radiological Facilities.

NE651 Nuclear Core Design And analysis I *(3 Credits - 4 Hours)*

Analytical investigation of areas of special importance to the design of nuclear reactors. includes development, evaluation and application of models for the Neutronic, thermal hydraulic and economic behaviour of both thermal and fast reactors. Typical problems arising in both design and operation of nuclear are considered. this course will involve extensive use of digital computer. separate groups of students will be assigned with projects of core design of different types of reactors.

NE652 Nuclear Core Design And analysis II *(3 Credits - 4 Hours)*

Design and analysis project of some type of reactor system. Extensive use of computer codes is required.

NE653 Nuclear Fuel Management *(3 Credits - 4 Hours)*

The nuclear fuel cycle, Reactor design and fuel loading requirements, Reactivity control and evaluation of reactor power distribution, Fuel depletion analysis, Nuclear power economics, IN-core fuel management, Plutonium utilization in power reactors, Utilization of computer codes to demonstrate the in-core fuel management procedures, Optimization techniques in nuclear fuel management.

NE670 Fast Reactor Physics *(3 Credits - 4 Hours)*

Application of the principles of reactor analysis and physics to the analysis of fast breeder reactors, Fast neutron cross-sections, Resonance interactions, Reactivity coefficients, Heterogeneity effects, fast reactor kinetics and excursion analysis.

NE671 Reactor Dynamics and Control *(3 Credits - 4 Hours)*

Time dependent reactivity, Reactivity feedback, Linear system stability, Fuel burnup, Space dependent reactor kinetics and Xenon oscillations, Reactor control, Optimal control, Reactor noise, Non-linear system, Low order modelling of plant dynamics, Application of dynamic codes.

NE623 Two Phase flow *(3 Credits - 4 Hours)*

Two Phase Flow Patterns, Two phase flow equations;(Basic Equations, The conservation of mass, the momentum theorem, the conservation of energy), homogeneous and separated flow equations. Hydrodynamics of two phase flow; (Flow patterns in adiabatic and Diabatic Flows, Void Fraction and Slip Ratio in Diabatic Flow, Modelling of Two-Phase Flow, Homogeneous Model, Separate -Phase Model, Models for Bubbly Flow, Models for

Slug Flow, Models for Annular Flow, Models for Stratified Flow, Pressure Drop in Two-Phase Flow, Local Pressure Drop, Analytical Models for Pressure Drop Prediction, Bubbly Flow, Slug Flow, Annular Flow, Stratified Flow, Empirical correlations, Friction pressure drop and void fraction correlations, Bubbly Flow, Slug Flow, Annular Flow, Critical Flow and Unsteady Flow), Flow boiling; (Pool boiling, convective boiling, Nucleate boiling in Flow, Film Boiling).

NE697 Special Topics *(3 Credits - 4 Hours)*

The topics are not listed in department programs and may vary from year to year according to interests of students and instructors.
M.S. students choose and study a topic under the guidance of the department coordinator. Typical contents include advanced fields of study according to recent scientific and technological developments in the related areas. Also, it could be studied from other related departments after getting the permission.

NE698 Graduate Seminar *(3 Credits - 4 Hours)*

This course help students to develop their research proposals, establishing and expanding their research skills and implementing their work through scholarly writing, which can be achieved through the seminar.
The seminar course must to be taken in the second semester of the registration and managed by an instructor who is responsible to prepare the final grade list of all the registered students.
Students must prepare and present their chosen topics through a scientific term paper, which can be shared and discussed with other students and department staff to gain their feedback.

NE699 M. Sc. Thesis *(6 Credits – 0 Hours)*

The student has to carry out a research project in one of the three branches. The research topic should tackle contemporary problems in the nuclear field and upon completion it must stand firm for publication.