NUCLEAR ENGINEERING PROGRAM

COURSE SYLLABI

Course:	NE 300 Fundamentals of Nuclear Engineering Calculations (3:3,0)
Course Description:	Ordinary differential equations of the first and second order applicable to nuclear engineering calculations. Power series solutions of differential equations. Laplace transformations. Use of Laplace transformations to solve ordinary differential equations. Fourier series and integrals. Partial differential equations and divergence theorem of Gauss. Legendre polynomials and Bessel functions.
Prerequisites:	MATH 204 Ordinary Differential Equations
Textbooks & required Materials	1. Kreyszig, E; Advanced Engineering Mathematics, John Wiley & Sons, 1998.

Course Learning Objectives:

By the completion of the course, the students should be able to:

1. Solve ordinary differential equations of first and second order.

2. Generate first and second order differential equations from nuclear engineering problems.

3. Apply his knowledge to solve these differential equations.

4. Solve differential equations by power series method and Laplace transforms.

5. Apply his knowledge with power series method to solve Legendre differential equation and hence to deduce Legendre polynomials.

6. Apply method of Forbenius to solve Bessel differential equation and hence to derive Bessel functions.

7. Understand periodic function, Fourier series and Fourier coefficients.

8. Apply his information and skills to obtain Fourier series of a function f(x) for different intervals.

9. Convert surface integral to volume integral and vice – versa.

10. Use the method of separation of variables to find solution of a partial differential equation relating to nuclear engineering problem.

Course Topics and their Duration:

Course Topics:	*Duration in weeks*
Special Functions	1
Solutions of first order differential equations	1
Applications of first order differential equations	1
Solutions of second order & higher order differential equations	1
Applications of second order differential equations	1
Power series solution of differential equations	1
Solutions of Bessel equation and Bessel function	1
Solution of Legendre equation and Legendre polynomials	1
Laplace Transforms, Solution of differential equation using Laplace Transform	1
Fourier Series	1
Fourier Series	1
Partial Differential equations	1
Application of Partial differential equation	1
Gauss's Divergence Theorem	1

Class Schedule:

- **Lectures: three lectures of 60 minutes each every week.**
- **Tutorials: two 2.0 hours session per week**

Course Contribution to Professional Component:

- Engineering science: 100%
- Engineering design: Non

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	M	-	-	L	M	-	M	-	-	-	M

L: Low

M: **Medium**

H: High

Prepared by: Dr. Sayed M. farid

Last Updated: Jan. 2008

Course:	NE 301 Atomic and Nuclear Principles for Nuclear Engineers (3:3,0)
Course Description:	Special theory of relativity. Electromagnetic waves. Quantum theory of light. Bohr's theory of the hydrogen atom. Spectrum of hydrogen atom. X-rays. Conductors, insulators and semiconductors.
Prerequisites:	PHY 102 Engineering Physics II
Textbooks & required Materials	1. Beiser A., Concept of Modern Physics McGraw Hill, 1989. 2. Karne, K.; Modern Physics; John Wiley & Sons, 1983.

Course Learning Objectives:

By the completion of the course, the students should be able to:

1. Discuss the concepts of relativistic time dilation, length contraction
2. Discuss the relationship between mass and energy.
3. Explain the propagation of electromagnetic waves
4. Explain the particle properties of waves (photoelectric and pair production effects)
5. Discuss the Heisenberg's principle of uncertainty
6. Discuss the equations for the energies of scattered photon and scattered electron in Compton Effect.
7. Explain the Bohr's model of the atom of hydrogen and its atomic spectra.
8. relate the quantum numbers to the electronic configuration of atoms
9. Explain how X-rays are produced, and interpret continuous and characteristic X-ray using Moseley's law
10. Explain the energy band theory for conductors, insulators and semiconductors. Define p-type and n-type semiconductor.

Course Topics and their Duration:

Course Topics:	*Duration in weeks*
1. Special theory of relativity, Reference frame and observer, Theory postulates. 2. Time dilation, Length contraction, 3. Relativistic mass, momentum and energy 4. Electromagnetic radiations 5. Duality wave-particle of the electromagnetic radiations. Classical versus quantum. 6. The Bohr's model of hydrogen atom 7. The Bohr's model , Energy level and spectra 8. The Bohr's model , Energy level and spectra 9. Quantum numbers and electronic configuration of atoms 10. X-rays: production and properties 11. Crystalline structure, Atomic bonds, Band theory of solids 12. Semiconductor devices	1 1 1 1 1 1 1 1 1 1 1 1

Class Schedule:

- **Lectures: Two lectures of 90 minutes each every week.**
- **Tutorials: two 2.0 hours session per week**

Course Contribution to Professional Component:

- Engineering science: 100%
- Engineering design: Non

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	H	-	-	-	M	-	-	-	M	-	-

M: **Medium**

H: High

Prepared by: Dr. Fathi Djouider

Jan. 2008

Last Updated:

Course:	NE 302 Nuclear Engineering Fundamentals (3:3,0)
Course Description:	Introduction: basic atomic and nuclear physics - Nuclear interactions: types of nuclear interactions, nucleons mass/energy and momentum conservation concepts, nuclear interactions kinematics, and nuclear interaction cross sections – Neutron Interactions: neutron scattering, neutron flux, neutron attenuation, spontaneous and induced fission interactions, fission chain reaction, and nuclear reactors – Radioactive Decay: decay modes, conservation laws, radioactive decay law, decay kinetics, activation analysis, and radiodating – Interaction of Radiation with Matter: charged particle interactions, and photons interaction mechanisms.
Prerequisites:	PHY 202E
Textbooks & required Materials	1. Robert M. Mayo **"**Introduction to Nuclear Concepts for Engineers", American Nuclear Society 1998. 2. J.R. Lamarsh and A.J. Baratta, "Introduction to Nuclear Engineering", Third Edition, Prentice Hall, 2001.

Course Learning Objectives:

By the completion of the course, the students should be able to:

1. Explain atomic and nuclear physics basic principles.
2. Explain general nuclear reactions and conservation laws.
3. Explain neutrons interactions and basic nuclear engineering concepts.
4. Demonstrate an application of neutrons interactions concepts to simple Geometry and introduction to fission interactions.
5. Explain fission chain reaction and describing thermonuclear fission reactors.
6. Introduce radioactivity and explain decay modes, conservation laws, and decay laws.
7. Introduce Laplace transforms and application to solving kinetics equations.
8. Explain decay kinetics and decay chains.
9. Demonstrate application of decay kinetics to activation analysis and radiodating.
10. Explain interactions of radiation with matter.

Course Topics and their Duration:

Course Topics:	*Duration in weeks*
Basic Units & Constants in NE	1
Fundamental Particles	
Special Relativity	1
Basics, Nuclide Chart, Shape & Size of nucleus	1
Mass Defect & Binding Energy, Separation Energy	
Nuclear Models	
Classification & Compound Nucleus	1
Conservation Laws, Mass/Energy Conservation	1
Reactions Cross Sections	
Neutron Interactions & Fission	1
Neutron Flux	
The Reaction Rate Equation	
One Speed Neutrons in a Slab	1
Reaction Cross Sections for Homogeneous Mixtures	
Introduction to Fission, Spontaneous &Induced Fission	
Thermal Neuron Induced Fission	1
Prompt and Delayed Neutrons	
Fission Yield and Decay Chains	
Fission Product Poisoning	1
Fission Chain Reaction	
Thermonuclear Reactors	
Radioactive Decay: Decay Modes	1
Energy Level Diagrams	
Radioactive Decay Law 1	
Radioactive Decay Law 2	
Laplace Transforms	1
Solving Differential Equations Using Laplace transforms	
Decay Kinetics	1
Activation Analysis	
Radiodating	1
Interaction of Radiation with Matter: Charged Particle Interactions	1
Photon Interaction Mechanisms	1

Class Schedule:

- **Lectures: three lectures of 60 minutes each every week.**
- **Tutorials: two 2.0 hours session per week**

Course Contribution to Professional Component:

- Engineering science: 100%
- Engineering design: Non

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	H	L	M	M	M	L	M	M	M	M	M

L: Low

M: **Medium**

H: High

Prepared by: Dr. Ashraf Hassan Shehata

Last Updated: Jan. 2008

Course:	NE 304 Introduction to Nuclear Engineering (2:2,0)
Course Description:	Application of radioactivity decay equations. Energy from fission and fuel burn up. Radiation shielding. Selection of nuclear materials for reactor cooling. Moderation and cladding. Multiplication factor (k). Neutron diffusion. Criticality equation. Rate of heat production and types of reactors.
Prerequisites:	NE 302 Nuclear Engineering Fundamentals
Textbooks & required Materials	Lamarsh, J. R.& Baratta A.J., Introduction to Nuclear Engineering (3^{rd} Ed.)

Course Learning Objectives:

By the completion of the course, the students should be able to:

1. Use the radioactive decay equations for compound decay, ^{14}C dating, ^{238}U dating, ^{40}K dating and neutron activation.
2. Apply the knowledge of nuclear reactions to calculate the energy released from nuclear fission and nuclear fuels.
3. Apply the knowledge of cross-sections for neutron reactions and reaction rates to calculate fuel consumption rate in a nuclear reactor for the production of electrical power.
4. Discuss different components of a nuclear reactor.
5. Discuss the material frequently used for different components of a reactor and the major steps in selecting the material.
6. Define and discuss infinite multiplication factor and effective multiplication factor.
7. Classify nuclear reactors according to their applications.
8. Use the knowledge of neutron flux and cross section to estimate the thermal power in a nuclear reactor.
9. Discuss neutron migration and hence deduce diffusion equation.
10. Discuss reactor radiation sources and methods of shielding.

Course Topics and their Duration:

Course Topics:	*Duration in weeks*
Decay Law, $T_{1/2}$, $T_{av.}$, T_E, Activity, units, Compound decay	1
Radioactive Equilibrium, ^{14}C dating, ^{238}U & ^{40}K dating, Neutron Activation, Problems,	1
Nuclear Reactions, Nuclear Fissions, Energy Calculations.	1
Cross-section for nuclear reactions, reaction rates.	1
Nuclear fuel performance, problems.	1
Nuclear Reactors, Components of Nuclear reactors, Cladding.	1
Reactor Materials, Multiplication factor.	1
Criticality calculation.	1
Heat sources in Reactor system, Reactor power.	1
Diffusion of neutrons, diffusion equation.	1
Neutron migration (slowing down), Problems.	1
Reactor radiation sources, Reactor shielding.	1
Shielding calculations.	1
Problems.	

Class Schedule:

- **Lectures: two lectures of 60 minutes each every week.**
- **Tutorials: two 2.0 hours session per week**

Course Contribution to Professional Component:

- Engineering science: 100%
- Engineering design: Non

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	M	-	L	-	M		-	-	-	M	L

L: Low

M: **Medium**

H: High

Prepared by: Dr. Sayed M. farid

Last Updated: Jan. 2008

Course:	NE 311 - Nuclear Reactor Analysis (3:3, 0)
Course Description:	Fission chain reaction, Nuclear reactors and their components Neutron flux, Diffusion equations, Neutron moderation, One group diffusion equation and criticality calculations, Reflected reactors, Multi-group calculations and heterogeneous reactors
Prerequisites:	Ne 300, ne 302
Textbooks & required Materials	J. R. Lamarsh, A. J. Baratta, *Introduction to Nuclear Engineering,* 3d ed., Prentice-Hall, 2001

Course Learning Objectives:

By the completion of the course, the students should be able to:

1. Analyze simple nuclear reactor core performance
2. Derive and determine solution to neutron diffusion equation using one group diffusion equation
3. Develop multi-group diffusion equations
4. Solve problems the one-group diffusion theory for multi-region reactors
5. Derive and solve the point reactor dynamic equation for a point reactor
6. Compute dynamics and safety characteristics using point kinetics models with reactivity feedback
7. Compute reactivity effects due to depletion and fission product buildup
8. Design heterogeneous reactors with specified characteristics

Course Topics and their Duration:

Course Topics:	*Duration in weeks*
1. Fission chain reaction	1
2. Nuclear reactors and their components	1
3. Neutron flux	1
4. Diffusion equations	1
5. Neutron moderation	2
6. One group diffusion equation and criticality calculations	1
7. Reflected reactors	1
8. Multi-group calculations and heterogeneous reactors	2
	1
	2

Class Schedule:

- **Lectures: three lectures of 60 minutes each every week.**
- **Tutorials: two 2.0 hours session per week**

Course Contribution to Professional Component:

- Engineering science: 100%
- Engineering design: Non

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	H	H	H	-	H	-	-	H	-	-	H

M: **Medium**

H: High

Prepared by: Dr. Mohammed Enani

Last Updated: Jan. 2008

Course:	NE 321 Nuclear Heat Transport (3:3,0)
Course Description:	Heat generation in homogeneous and heterogeneous reactors, reactor shutdown heat generation, temperature distributions in fuel, cladding and coolant, core heat transfer coefficients. Two-phase flow, critical heat flux and burnout, boiling channel hydraulics. Boiling water reactors and pressurized water reactors.
Prerequisites:	NE 311 Nuclear Reactor Analysis MEP 261 Thermodynamics I
Textbooks & required Materials	M. M. El-Wakil, Nuclear Heat Transport, American Nuclear Society, 1978.

Course Learning Objectives:

By the completion of the course, the students should be able to:

1. E Explain the process of heat generation inside a nuclear reactor.
2. Calculate the volumetric heat generation at any location inside a reactor and look for the data required for calculation.
3. Calculate heat generated in the radiation shield inside nuclear reactor core.
4. Explain the process of heat generation after reactor shutdown and its variation with operation time and time after shutdown.
5. Apply his knowledge with homogeneous reactors to calculate heat generation in heterogeneous nuclear reactors.
6. Calculate temperature distribution in nuclear fuel in all dimensions.
7. Describe the function and behavior of major nuclear reactor core components during reactor operation and heat generation.
8. Use critical heat flux and hot spot factors as limiting operating and design parameters.
9. Apply his information and computer skills to reactor thermal design.

Course Topics and their Duration:

Course Topics:	*Duration in weeks*
Introduction to the course Review, Atomic and nuclear structure and reactions Review, Neutron flux distribution in cores	1 1 1

Reactor heat generation	1
Reactor heat generation	1
Heat conduction in reactor elements; General and 1D SS	1
Heat conduction in reactor elements; General and 1D SS (cont.)	1
Heat conduction in reactor elements; General and 1D SS (cont.)	1
Heat conduction in reactor elements; Some special 1D SS	1
Heat conduction in reactor elements; Some special 1D SS (cont.)	1
Heat conduction in reactor elements; 2D steady state cases	1
Heat transfer with change in phase	1
Heat transfer with change in phase (cont.)	1
Two phase flow	1
The boiling core	

Class Schedule:

- **Lectures: two lectures of 90 minutes each every week.**
- **Tutorials: two 2.0 hours session per week**

Course Contribution to Professional Component:

- Engineering science: 100%
- Engineering design: Non

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	**M**	**--**	**M**	**-**	**M**	-	-	-	-	-	-

M: **Medium**

Prepared by: Dr. Abdulghani Melaibari

Last Updated: Jan. 2008

Course:	NE 330 Nuclear Materials (3:3,0)
Course Description:	Crystal structure of solids, Mechanical properties of metals, Fission product behavior in nuclear fuel, Uranium, Structural metals; Aluminum, Zirconium, and stainless steel, Ceramics and cermets; structure, mechanical properties, thermal properties, manufacturing, and radiation damage
Prerequisites:	1. Nuclear Reactor Analysis (NE 311) 2. Material Science (ChE 210)
Textbooks & required Materials	Charles O. Smith, Nuclear Reactor Materials, Addison-Wesley Publishing Company

Course Learning Objectives:

By the completion of the course, the students should be able to:

1. Review those aspects of fundamental concepts of nuclear reactors that are pertinent to understand the working condition of nuclear reactors.
2. Review those aspects related to crystal structure fundamentals.
3. Study the factors that affect on material selection in the nuclear reactors.
4. Understand the role of materials in reactors.
5. Review those aspects of fundamental of theory of radiation damage in materials.
6. Show how radiation affects the mechanical properties of fuel, cladding, and structural materials in nuclear reactors.
7. Apply the concepts of selecting a material to uranium as a nuclear fuel.
8. Understand the radiation damage picture of uranium in reactors.
9. Explains the behavior of metallic, ceramic, and cermet fuel how they are formed, and how they affect properties of the fuel and other major reactor components.
10. Compare between metallic, ceramic, cermet materials from radiation, thermal, and mechanical points of view.
11. Make an oral presentation using Power Point, showing crystal structure outlines, and radiation damage to some nuclear structural materials.

Course Topics and their Duration:

Course Topics:	*Duration in weeks*
1. Introduction: types of reactor and their materials.	1
2. Crystal structure of solids; point defect types and structures.	1
3. Radiation deformation in solids: point, line, and volume defects.	1
4. Mechanical properties of metals.	1
5. Fission product behavior in nuclear fuel; fission products, swelling and release.	1 1
6. Polycrystalline solids; recrystallization and grain growth.	1
7. The role of materials in reactors.	1
8. Radiation damage in metals.	1
9. Uranium; structure, mechanical properties, thermal properties, manufacturing, and radiation damage.	1
10. Structural metals; Aluminum, Zirconium, and stainless steel.	
11. Ceramics and cermets; structure, mechanical properties, thermal properties, manufacturing, and radiation damage.	1
12. Nuclear fuel elements.	

Class Schedule:

- **Lectures: three lectures of 60 minutes each every week.**
- **Tutorials: two 2.0 hours session per week**

Course Contribution to Professional Component:

- Engineering science: 100%
- Engineering design: Non

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	H	-	-	-	H	-	H	M	L	L	-

L: Low

M: **Medium**

H: High

Prepared by: Eng. Mahmoud Elsayed Elgohary

Last Updated: Jan. 2008

Course:	NE 340 Nuclear Radiation Measurements (4:3,3)
Course Description:	General properties of radiation detectors: pulse and currents types, detection efficiencies, resolution. Properties of gas filled detectors, ionization chambers, proportional counters, and Geiger-Muller detectors. Experiments on alpha, beta gamma and neutron radiation measurements. Properties of scintillation detectors, solid and liquid detectors, organic and inorganic detectors. Analysis of experimental data.
Prerequisites:	NE 302 Nuclear Engineering Fundamentals
Textbooks & required Materials	1. G. F. Knoll, Radiation Detection and measurements, Third edition, John Wiley, 2000. 2. N. Tsoulfanidis, Measurements and Detection of Radiation, third edition, Taylor & Francis.

Course Learning Objectives:

By the completion of the course, the students should be able to:

1. Define detection overall and intrinsic efficiencies
2. Describe pulse formation in pulse detector
3. Measure gamma ray intensity and analyses spectrum
4. Measure beta ray intensity and analyze spectrum
5. Measure alpha ray intensity and analyze spectrum
6. Measure radiation exposure
7. Describe how gas filled detector functions & the counter functions
8. Describe how scintillation detector functions
9. Describe how solid state semi-conductor detector functions
10. Design a system for meas. back-scattered neutrons to identify petrol. products

Course Topics and their Duration:

Course Topics:	*Duration in weeks*
Interaction of radiation with matter	1
Simplified detector model,	1
modes of operation of detectors	1
energy resolution, detection efficiency, dead time	1
energy resolution, detection efficiency, dead time	1
Alpha and beta spectra	1
Gamma spectra	1
General properties of gas filled detectors	1
Ionization chambers, proportional counters	1
Proportional counters, G-M counters	1
General properties of scintillation detectors	1
Solid scintillation detectors and applications	1
Liquid scintillation detectors and applications	1
General properties of semiconductor detectors	1
Spectra and application of semiconductor detectors	1
Review of project work	1

Class Schedule:

- **Lectures: three lectures of 60 minutes each every week.**
- **Tutorials: two 2.0 hours session per week**

Course Contribution to Professional Component:

- Engineering science: 80%
- Engineering design: 20%

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	H	H	H	H	M	M	M	M	M	M	H

M: **Medium**

H: High

Prepared by: Professor Samir Alzaidi

Last Updated: Jan. 2008

Course:	NE 351 Radiation Protection I (3:3,0)
Course Description:	Radioactivity. Half-life. Decay constant. Serial transformation. Interaction of radiation with matter. Radiation Dosimetry: Exposure measurements. Absorbed dose measurements. Exposure – Dose relationship. Specific gamma ray emission. Dose commitment. Biological effects of radiation. Dose limits.
Prerequisites:	NE 302 Elements of Nuclear Physics for Engineers
Textbooks & required Materials	1. Herman Cember, Introduction to health Physics, McGraw Hill, 3rd Ed., 1996.

Course Learning Objectives:

By the completion of the course, the students should be able to:

1. Define "Radioactivity" and discuss the transformation mechanisms for α, β, and γ emission from nucleus.
2. Examine the basics of radioactive decay kinetics including determining half-life, activity, secular equilibrium and transient equilibrium. Apply this knowledge to solve problems related to activity, half-life, equilibrium, and specific activity.
3. Discuss how gamma photons interact with matter
4. Discuss how α and β particles interact with matter
5. Gain understanding of the concepts of dosimetry and exposure.
6. Explain different exposure measuring instruments
7. Use of the Gamma ray emission constant (Γ) to calculate dose and exposure
8. Calculate dose rate and total dose for internal radiation sources
9. Explain the basic biological effects of radiation on human cells. Explain acute, delayed and genetic effects of radiation. Explain the stochastic and non-stochastic effects of radiation
10. Give internet research based oral presentation on different aspects of the biological effects of radiation

Course Topics and their Duration:

Course Topics:	*Duration in weeks*
Radioactivity and Transformation Mechanism	1
Transformation Kinetics, half life, Activity, Specific Activity, Units.	1
Serial Transformation- Equilibrium of growth and decay.	1
Interaction of beta particles with matter, Mechanism of Energy loss	1
Interaction of alpha particles with matter, Mechanism of Energy loss	1
Gamma radiation-Exponential absorption, interaction mechanism,	1
Photoelectric, Compton effects and pair production.	1
Radiation dosimetry-Absorbed dose, Exposure,	1
Exposure measurement,-Air well chamber, Free air chamber.	1
Exposure-dose relationship	1
Specific gamma ray emission.	1
Biological effects of radiation-Dose response characteristic, direct and indirect	1
actions. Radiation effects-Acute effects, Delayed effects, Genetic effects.	1
	1

Class Schedule:

- **Lectures: TWO lectures of 90 minutes each every week.**
- **Tutorials: two 2.0 hours session per week**

Course Contribution to Professional Component:

- Engineering science: 100%
- Engineering design: Non

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	**M**	**L**	-	-	**L**	-	-	-	M	M	-

L: Low

M: **Medium**

Prepared by: Dr. Fathi Djouider

Last Updated: Jan. 2008

Course:	NE 360 Radioisotope applications 1 (3:2,3)
Course Description:	Radioisotopes Engineering, Applications using gamma ray attenuation, Applications using gamma ray scattering, Borehole logging, Applications using beta particles and electrons, Radio sterilization
Prerequisites:	NE 351 (Radiation Protection I)
Textbooks & required Materials	1. Foldiak, G., Industrial Application of Radioisotopes, Elsevier, New York, 1986. 2. Gardner, G.P. and Ely, R.L., Radioisotope Measurement & Applications in Engineering. 3. Geir Anton Johanson and Peter Jackson., Radioisotope Gauges for Industrial Process Measurement, John Wiley & Sons.

Course Learning Objectives:

By the completion of the course, the students should be able to:

1- Design a liquid level gauge based on gamma ray attenuation.

2- Design metal thickness gauge based on gamma ray attenuation.

3- Design a thickness gauge based on gamma backscattering.

4- Design a density gauge using radioactivity.

5- Calculate gamma ray attenuation in multi-layers.

6- Calculate gamma ray backscattering energy.

7- Calculate detector response to back scattered radiation.

8- Calibrate NaI(Tl) detector and counting system for gamma ray energy.

9- Calibrate Cd-Tl x-ray detector and counting system for characteristics x-ray.

10. Design an experiment by selecting appropriate radioactive source for radiographic imaging.

11. Design an experiment for identifying unknown metal or alloy.

12. Describe an experiment for using contrast media for better contrast in x-ray radiography.

13. Study Neutron Activation analysis and apply the same in well-logging

Course Topics and their Duration:

Course Topics:	*Duration in weeks*
Production of Radioisotopes	1
Radio-Tracing Principles and Techniques	1
Radio-Tracer Applications	1
Radio-gauging principles and techniques	1
Radio-gauging with charged particles	2
Radio-gauging with e m radiation	2
Radio-gauging with neutrons	2
Radiography	1
Miscellaneous Applications of radioisotopes	1

Class Schedule:

- **Lectures: three lectures of 60 minutes each every week.**
- **Tutorials: two 2.0 hours session per week**

Course Contribution to Professional Component:

- Engineering science: 100%
- Engineering design: Non

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	**M**	**H**	**M**	**L**	**M**	**-**	**M**	**-**	**L**	**-**	**M**

L: Low

M: **Medium**

H: High

Prepared by: Dr. Sayed M. farid

Last Updated: Jan. 2008

Course:	**NE 390 – Summer Training (2:0,0) – Required Core Course**

Course Description:

10 weeks of training in industry under the supervision of a faculty member. Students have to submit a report about their achievements during training in addition to any other requirements assigned by the Department.

Prerequisites: NE 340, NE-451

Textbooks & required Materials None.

Course Learning Objectives:

By the completion of the summer training, the student will be able to:

1. Formulate an objective or mission statement that identify the real problem and describe the expected outcomes of the training activity.
2. Break-down a work environment into its units and work functions, and describe how these units are assembled into a whole entity.
3. Describe a professional organizational structure, its size and how it is related to its main products and to market issues.
4. Exhibit integrity, punctuality, and ethical behavior in engineering practice and relationships.
5. Demonstrate enthusiasm and business focusing.
6. Establish successful relationships with team members, advisors, and clients to understand their needs and to achieve or exceed agreed-upon quality standards.
7. Maintain focus to complete important tasks on time and with high quality, amidst multiple demands
8. Relate practical work to previous knowledge from basic sciences, engineering fundamentals, and discipline related courses.
9. Collect and review related data such as technical information, regulations, standards, and operational experiences from credible literature resources
10. Utilize prior knowledge, independent research, published information, and original ideas in addressing problems and generating solutions
11. Monitor achievement, identify causes of problems, and revise processes to enhance satisfaction
12. Communicate, clearly and concisely, training details and gained experience, both orally and in writing, using necessary supporting material, to achieve desired understanding and impact.

Course Topics and their Duration:

Course Topics:	*Duration in weeks*
1. Acquainting the trainee by the company, its work environment, organizational structure, products, costumers, engineering units, and quality system.	2
2. Familiarizing the trainee of one production or design unit with deep understanding of the work environment, regulations, standards, etc...	1
3. Allocating the trainee to a project team and allowing him to study and collect necessary data about the project using internal and external data sources.	1
4. Working as a team member to execute assigned tasks with the following objectives: 1. Apply engineering practices related to his specialization. 2. Enhance team work skills. 3. Relate practical work to his engineering knowledge. 4. Use modern engineering tools such as equipment and computer software. 5. Use project management techniques. 6. Complete assigned tasks on time with high quality. 7. Develop personal communication skills.	6

Class Schedule:

- **Oral Presentation after submitting a written training report; both evaluated by at least 2 faculty members**

Course Contribution to Professional Component:

- Engineering science: None
- Engineering design: None
- Others: 100%

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	-	-	-	3	-	3	3	-	-	-	3

***1: Low level (knowledge & Comprehension), 2: Medium (Application & Analysis), 3: High (Synthesis & Evaluation)**

Prepared by: Dr. Mohammad Subian Al-Johani

Last Updated: April 2008

Course:	NE 411 - Nuclear Reactor Analysis (2:2, 1)
Course Description:	Prompt neutron lifetime, Reactor with no delayed neutrons, Reactor with, delayed neutrons, The prompt critical state, Control rods and chemical, him and their reactivity worth, Reactivity coefficients, Temperature coefficients, Moderator coefficient, Void coefficient, Fission product poisoning, Equilibrium Xenon
Prerequisites:	NE 311
Textbooks & required Materials	J. R. Lamarsh, A. J. Baratta, *Introduction to Nuclear Engineering,* 3d ed., Prentice-Hall, 2001 J. J. Duderstadt, L. J. Hamilton, *Nuclear Reactor Analysis,* John Wiley & Sons, 1976

Course Learning Objectives:

By the completion of the course, the students should be able to:

1. Analyze simple nuclear reactor core performance
2. Derive and determine solution to neutron diffusion equation using one group diffusion equation
3. Develop multi-group diffusion equations
4. Solve problems the one-group diffusion theory for multi-region reactors
5. Derive and solve the point reactor dynamic equation for a point reactor
6. Compute dynamics and safety characteristics using point kinetics models with reactivity feedback
7. Compute reactivity effects due to depletion and fission product buildup
8. Design heterogeneous reactors with specified characteristics

Course Topics and their Duration:

Course Topics:	*Duration in weeks*
Classification of time problems	1
Prompt neutron lifetime	1
Reactor with no delayed neutrons	1
Reactor with delayed neutrons	1
The prompt critical state	1
The prompt jump or drop	1
Small Reactivities	1
Control rods and chemical shim and their reactivity worth	1
Reactivity coefficients	1
Temperature coefficients	1
Moderator coefficient	1
Void coefficient	1
Fission product poisoning	1
Equilibrium Xenon	1
Xenon after shutdown and reactor deadtime	1

Class Schedule:

- **Lectures: tow lectures of 60 minutes each every week.**
- **Tutorials: two 2.0 hours session per week**

Course Contribution to Professional Component:

- Engineering science: 100%
- Engineering design: Non

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	H	L	L	L	H	L	M	L	L	L	M

L: Low

M: **Medium**

H: High

Prepared by: Dr. Ashraf Hassan Shehata

Last Updated: Jan. 2008

Course:	NE 450 Radiation Shielding design (3:3,1)
Course Description:	Principles of Radiation Shielding Design, Attenuation of Nuclear Radiation, Shield Layout Analysis and Design, Gamma Ray, X-ray and Neutron Shielding, Principles of Reactor Shielding and Use of Computers to Solve Shielding Problems.
Prerequisites:	NE 302 Nuclear Engineering Fundamentals
Textbooks & required Materials	1. Lamarsh, J. R.& Baratta A.J., Introduction to Nuclear Engineering (3^{rd} Ed.) 2. Chilton, A.B., Shultis, J.K. & Faw, R.E., Principles of Radiation Shielding

Course Learning Objectives:

By the completion of the course, the students should be able to:

1. Calculate shield thickness around a point gamma source that reduces exposure to desired level.
2. Calculate shield thickness over contaminated land that reduces exposure to desired level.
3. Design a shield for a gamma source used in a level gauge.
4. Calculate exposure at the surface of a person injected by radioactive materials.
5. Design a shield around a wire irradiated inside a nuclear reactor.
6. Calculate exposure rate outside two layer shield of a gamma beam.
7. Defline: exposure, effective dose, entrance surface dose. Neutron removal cross section.
8. Design a shield for a neutron generator inside a room.
9. Describe equipment for measuring exposure.
10. Describe equipment for measuring neutron dose.
11. Calculate shield thickness for primary x-ray machine.
12. Calculate fast neutron dose due to a fission source at certain depth in water.

Course Topics and their Duration:

Course Topics:	*Duration in weeks*
Review of gamma and neutron radiation interaction	1
Introduction to gamma ray shielding, meanings of exposure & dose, direct & scattered radiation	1
Good geometry attenuation, broad beam attenuation, build-up factor.	1
Gamma point source shielding	1
Gamma ray line source shielding	1
Gamma ray planar source shielding	1
Internal source shielding	1
Gamma ray multi-layer shielding	1
Removal cross-section, Neutron removal in water and by flat attenuator	1
Neutron shielding	1
Nuclear reactor shielding	1
Neutron generator shielding, X-ray shielding	1
Shielding X-rays -Primary shielding	1
X-ray secondary radiation shielding	1

Class Schedule:

- **Lectures: three lectures of 60 minutes each every week.**
- **Tutorials: two 2.0 hours session per week**

Course Contribution to Professional Component:

- Engineering science: 100%
- Engineering design: Non

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	M	H	H	-	M	L	-	L	-	-	M

L: Low

M: **Medium**

H: High

Prepared by: Dr. Samir Abdul-Majid

Last Updated: Jan. 2008

Course:	NE 451 Radiation Protection II (4:3,3)
Course Description:	Radiation protection guides such as ICRP, NCRP etc., Radiation safety criteria, Annual Limit of Intake (ALI), Derived Air Concentration (DAC), Maximum Permissible concentration (MPC), Health Physics instruments, Diagnostic and therapeutic x-ray shielding, Basic principles for external and internal radiation protection and radioactive waste management.
Prerequisites:	NE 351 Radiation Protection I
Textbooks & required Materials	Herman Cember, Introduction to health Physics, McGraw Hill, 3rd Ed., 1996.

Course Learning Objectives:

By the completion of the course, the students should be able to:

Understand the role of organization that set Radiation Safety Guides
Application of basic recommendations of radiation protection such as Justification, Optimization, and dose limitation.
Estimate the population risk based on collective dose.
Differentiate between stochastic and non- stochastic effects.
Calculate the derived limits (ie. ALI, DAC,MPC…) from basic limits.
Determine which survey meters, or dose marinating instruments should be used in the field.
Understand the three basic principles of external radiation protection Time, Distance , Shielding
Test the existing shielding in any X – ray facility and give recommendation.
Explain different exposure and dose measuring instruments
Apply specific Gamma ray emission constant (Γ́) to estimate exposure.
Explain acute, delayed and genetic effects of radiation.
Explain RBE and QF and hence calculate dose equivalent.

Course Topics and their Duration:

Course Topics:	*Duration in weeks*
Radiation protection guides such as ICRP, NCRP etc.	1
Radiation safety criteria, Annual Limit of Intake (ALI), Derived Air Concentration (DAC) and Maximum Permissible concentration (MPC)	2
Health Physics instruments	2
Diagnostic and therapeutic x-ray shielding	2
Basic principles for external radiation protection	2
Basic principles for internal radiation protection	2
Radioactive waste management	1

Class Schedule:

- **Lectures: Two lectures of 90 minutes each every week.**
- **Lab: One 2.0 hours session per week**

Course Contribution to Professional Component:

- Engineering science: 75%
- Engineering design: 25%

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	**H**	**H**	**H**	**L**	**M**	-	**M**	**M**		**M**	**M**

L: **Low** M: **Medium** H**: High**

Prepared by: Dr. Abdulrahim Kinsara

Last Updated: Jan. 2008

Course:	**NE 499 – BS Project (4: 2, 4) – Required Core Course**
Course Description:	Selection of topic, Literature review, Project design planning, Arranging for data collection and experimental work, Interim report, Experimental work and data collection or field study (if any), Data processing analysis and results, Preparation of a first draft of the final report, Presentation of the project.
Prerequisites:	NE 340, NE 451

Course Learning Objectives:

By the completion of the BS Project, the students should be able to:

1. Analyze a project statement, brief, or proposal to identify the real problem and the most relevant needs and operational constraints.
2. Identify potential costumers, their needs, and their operational constraints.
3. Collect and review related data such as technical information, regulations, standards, and operational experiences from credible literature resources.
4. Integrate previous knowledge from mathematics, basic sciences, engineering fundamentals and discipline related courses to address the problem.
5. Discuss all applicable realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
6. Define design objectives, measures of design viability, and the evaluation criteria of the final project, and reformulate the problem based on collected data.
7. Generate possible solutions; compare alternatives, and select one alternative based on evaluation criteria and feasibility analysis.
8. Plan an effective design strategy and a project work plan, using standard project planning techniques, to ensure project completion on time and within budget.
9. Implement a planned design strategy for an Experimental Design Project, if applicable:
   - 9.1 Identify experimental variables and parameter with ranges and desired accuracies.
   - 9.2 Select appropriate experimental tools such as sensors, instruments, and software.
   - 9.3 Explain a reliable experimental setup and experimental procedure that solves the problem.
   - 9.4 Explain efficient measures to deal responsibly with safety issues and environmental hazards.
   - 9.5 Use appropriate measurement techniques to ethically collect and record data.
   - 9.6 Analyze experimental data using appropriate tools such as data reduction and statistical analysis.
   - 9.7 Perform uncertainty analysis.
   - 9.8 Judge, verify, and validate the experimental result by comparing them with theory and/or previous experimental works.
10. Implement a planned design strategy for a Product-Based Design Project, if applicable:
    - 10.1 Identify design parameters as well as assumptions.
    - 10.2 Carry out initial design calculations using modern engineering tools.
    - 10.3 Use modern engineering tools to estimate the performance parameters of the initial design.
    - 10.4 Use constraint analysis and trade-off studies of the design parameters to refine the initial design and obtain a final optimized design.
    - 10.5 Evaluate the project related environmental, social, health and safety issues, as well as hazards anticipated by the project.
    - 10.6 Evaluate project success in satisfying customer's needs, design criteria, and operational constraints.
11. Communicate design details and express thoughts clearly and concisely, both orally and in writing, using necessary supporting material, to achieve desired understanding and impact.
12. Demonstrate ability to achieve project objectives using independent, well organized, and regularly reported multidisciplinary team management techniques that integrate, evaluate, and improve different skills of team members.

Course Topics and their Duration:

Course Topics	*Duration in weeks*
1. Project selection and team formation	1
2. Problem Definition	2
3. Literature review and data collection	3
4. Problem formulation:	3
a. Knowledge integration	
b. Operational and realistic constraints	
c. Design objectives	
d. Evaluation criteria	
5. Design options and initial layout	2
6. Work plan and budgeting	1
7. Progress report and oral presentation	1
8. Implementation phase	7
9. Design refinement	3
10. Final report and oral presentation	3

Class Schedule:

- **2 general audience oral presentations of 30 minutes each**

Course Contribution to Professional Component:

- Engineering science: Non
- Engineering design: 100%

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	3	-	3	3	3	3	3	3	3	3	3

***1: Low level (knowledge & Comprehension), 2: Medium (Application & Analysis), 3: High (Synthesis & Evaluation)**

Prepared by: Dr. Mohammad Subian Al-Johani

Last **Updated**: Jan 2008