# Course Syllabi

# Nuclear Engineering (Medical Physics)Program

Faculty of Engineering
King Abdulaziz University
Jeddah, Kingdom of Saudi Arabia

July 1st, 2014

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
| --- | --- | --- | --- | --- | --- | --- |
| | | | Th. | Pr. | Tr. | Credit |
| **Atomic and Nuclear Principles for Engineers** | **NE 301** | **هـ ن 301** | **2** | **1** | **-** | **2** |
| **Prerequisites** | | **PHYS 202** | | | | |
| Special theory of relativity. Wave properties of matter. Quantum theory of light. Wave function and its physical significance. Origin of quantum hypothesis. De Broglie's hypothesis of matter wave & its experimental verification. Uncertainty principle. Atomic structure. Bohr atom and atomic spectra. X-rays. Periodic table. Free Electron model of solids: conductors, insulators and semiconductors. Intrinsic and extrinsic semiconductors. p-n junctions. Sizes of nuclei. Atomic masses. Binding energy. Excited states of nuclei. $\alpha$-,$\beta$- and $\gamma$-decay. Internal conversion. Electron capture. Conservation laws for radioactive decay. | | | | | | |

Faculties and departments requiring this course (if any): None

***<u>Textbook</u>*:** A. Beiser, Concepts of Modern Physics. McGraw-Hill Science; 6th edition (2002).

***Reference:*** K. S. Krane, Modern Physics. Wiley; 2nd edition (1995).

***Course Learning Objectives: By completion of the course, the students should be able to:***

1. Define the concepts of relativistic time dilation, length contraction.
2. Define 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.

| ***NO*** | ***Topic Covered During Class:*** | ***Duration in Weeks*** |
|---|---|---|
| 1 | Special theory of relativity, Reference frame and observer, Theory postulates | **1** |
| 2 | Time dilation, Length contraction | **1** |
| 3 | Relativistic mass, momentum and energy | **2** |
| 4 | Electromagnetic radiations | **1** |
| 5 | Duality wave-particle of the electromagnetic radiations. Classical versus quantum | **1** |
| 6 | The Bohr's model of hydrogen atom | **1** |
| 7 | The Bohr's model , Energy level and spectra | **2** |
| 8 | Quantum numbers and electronic configuration of atoms | **1** |
| 9 | X-rays: production and properties | **1** |
| 10 | Crystalline structure, Atomic bonds, Band theory of solids | **1** |
| 11 | SolidState Physics | **1** |
| 12 | Semiconductor devices | **1** |

***Class Schedule:***

- Lecture: two 1.5 hour sessions per week
- Tutorials: one 3.0 hours session per week

***Course Contribution to professional Component:***

- Engineering science: 100%
- Engineering design:  0%

***Course Relationship to Student Outcomes:***

| | *Student Outcomes* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***a*** | *b* | *c* | *d* | *e* | *f* | *g* | *h* | ***i*** | *j* | *k* |
| Educational Level | ***I*** | | | | | | | | ***I*** | | |

I: Introduce, R: Reinforce; & E: Emphasized

***Prepared By:  Dr. Fathi Dhjouidar***

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Nuclear Engineering Fundamentals** | **NE 302** | **302 هـ ن** | **3** | **0** | **0** | **3** |
| **Co-requisites** | | **NE 301** | | | | |
| The strong interaction between nucleons. Liquid drop and shell models. Interaction of ionizing radiation with matter: Slowing down of electrons. Positive ions and fission fragments in matter. Collision losses: the Bethe-Bloch stopping power formula. Interactions of X- and $\gamma$-ray photons with matter: photo-electric effect, Compton scattering, pair production, photo-nuclear reactions. The interaction of neutrons with matter: Slowing down and absorption of neutrons. Nuclear fission. The neutron cycle of thermal reactors. Nuclear fusion as an energy source. Cosmic rays. | | | | | | |

Faculties and departments requiring this course (if any): **None**

***Textbook:*** J.R. Lamarsh and A.J. Baratta, Introduction to Nuclear Engineering. Prentice Hall; 3rd edition (2001).

***Reference:*** R. M. Mayo**,** Introduction to Nuclear Concepts for Engineers. American Nuclear Society (1998).

***Course Learning Objectives: By 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 radio-dating.
10. Explain interactions of radiation with matter.

| *No* | *Topic Covered During Class:* | *Duration in Weeks* |
|---|---|---|
| **1** | Basic Units & Constants in NE | **1** |
| **2** | Nuclide Chart, Shape & Size of nucleus, Mass Defect & Binding Energy, Separation Energy, Nuclear Models | **2** |
| **3** | Classification & Compound Nucleus, Conservation Laws, Mass/Energy, Conservation | **2** |
| **4** | Reactions Cross Sections, Neutron Interactions & Fission, Neutron Flux, The Reaction Rate Equation | **1** |
| **5** | One Speed Neutrons in a Slab, Reaction Cross Sections for Homogeneous Mixtures, Introduction to Fission, Spontaneous &Induced Fission | **1** |
| **6** | Thermal Neuron Induced Fission, Prompt and Delayed Neutrons, Fission Yield and Decay Chains | **1** |
| **7** | Fission Product Poisoning, Fission Chain Reaction, Thermonuclear Reactors | **1** |
| **8** | Radioactive Decay: Decay Modes, Energy Level Diagrams | **1** |
| **9** | Radioactive Decay Laws | **1** |
| **10** | Decay Kinetics | **1** |
| **11** | Radiation Activation Analysis & Radiodating | **2** |
| **12** | Interaction of Radiation with Matter:Charged Particle Interactions, & Photon Interaction Mechanisms | **1** |

***Class Schedule:***

- **Lecture :** three 1 hour sessions per week
- **Lab :** one 3 hours session per week

***Course Contribution to professional Component:***

- Engineering science: 100 %
- Engineering design: 0 %

***Course Relationship to Student Outcomes:***

| | *Student Outcomes* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***a*** | *b* | *c* | *d* | ***e*** | *f* | *g* | *h* | ***i*** | *j* | *k* |
| Educational Level | ***I*** | | | | ***I*** | | | | ***I*** | | |

I: Introduce, R: Reinforce; & E: Emphasized

***Prepared By: Dr. Ahamd Hussein***

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | **Th.** | **Pr.** | **Tr.** | **Credit** |
| **Nuclear Radiation Measurements** | **NE 340** | **340 هـ ن** | **3** | **2** | **-** | **4** |
| **Prerequisites** | | **NE 302, EE 251** | | | | |
| Counting statistics. Properties of ionization chambers. Proportional counters. Geiger-Muller counter. Scintillation detectors. Solid-state and other types of detectors. Radiation monitoring equipment. Quantitative and qualitative analysis of radiation. Experiments on alpha, beta, gamma, and neutrons measurements. | | | | | | |

Faculties and departments requiring this course (if any): None

***Textbook:*** G. F. Knoll, Radiation Detection and measurements. John Wiley; 3rd edition (2000).

***Reference:*** N. Tsoulfanidis, Measurements and Detection of Radiation. Taylor & Francis; 3rd edition (2010).

***Course Learning Objectives: By 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 an application specific detection system

| ***NO*** | ***Topic Covered During Class:*** | ***Duration in Weeks*** |
|---|---|---|
| 1 | Interaction of radiation with matter | **1** |
| 2 | Simplified detector model, modes of operation of detectors | **1** |
| 3 | energy resolution, detection efficiency, dead time | **1** |
| 4 | Alpha and beta spectra | **1** |
| 5 | Gamma spectra | **1** |
| 6 | General properties of gas filled detectors | **1** |
| 7 | Ionization chambers, proportional counters | **1** |
| 8 | Proportional counters, G-M counters | **1** |
| 9 | General properties of scintillation detectors | **1** |
| 10 | Solid scintillation detectors and applications | **1** |
| 11 | Liquid scintillation detectors and applications | **1** |
| 12 | General properties of semiconductor detectors | **1** |
| 13 | Spectra and application of semiconductor detectors | **1** |
| 14 | Review of project work | **1** |

***Class Schedule:***

- **Lecture**: Three 1.0 hour sessions per week
- **Tutorials**: Two 2.0 hours sessions per week

***Course Contribution to professional Component:***

- Engineering Science: 80 %
- Engineering Design: 20 %

***Course Relationship to Student Outcomes:***

| | *Student Outcomes* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***a*** | ***b*** | ***c*** | ***d*** | ***e*** | ***f*** | ***g*** | ***h*** | ***i*** | ***j*** | ***k*** |
| Educational Level | ***R*** | ***R*** | | | | | ***I*** | | | | ***I*** |

I: Introduce, R: Reinforce; & E: Emphasized

***Prepared By: Dr. Samir Alzaidi***

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Nuclear Electronics I** | **NE 341** | **341 هـ ن** | **3** | **2** | **-** | **4** |
| **Prerequisites** | | **EE 251** | | | | |
| DC and AC circuits, introduction to semiconductors, diode applications, special-purpose diodes, Bipolar Junction transistors - BJT, transistor Bias Circuits. Some advance topics in electronics such as power amplifiers, operation amplifiers, and oscillators & timers. | | | | | | |

Faculties and departments requiring this course (if any): None

***<u>Textbook:</u>*** T. L. Floyd, Electronic Devices. Prentice Hall International; 5th edition (1999).

***<u>Reference:</u>*** A. P. Mavino Electronic Principles. McGraw-Hill Science/Engineering/Math; 6th Edition (1998).

***Course Learning Objectives: By completion of the course, the students should be able to:***

1. Review and identify the DC & AC circuits
2. Explain the semiconductor theory
3. Describe the general purpose diodes
4. Describe the special purpose diodes
5. Describe general & special purpose diodes applications
6. Explain the bipolar junction transistors (BJTs)
7. Explain the field effect transistors
8. Describe the power amplifiers
9. Describe the theory of operational amplifiers
10. Use advanced electronic devices such as op-am, oscillators, & timers.

| ***NO*** | ***Topic Covered During Class:*** | ***Duration in Weeks*** |
|---|---|---|
| 1 | Review Fundamentals in Electronics<br>• Direct Current Circuits - DC<br>• Alternating Current Circuits - AC | **2** |
| 2 | Introduction to Semiconductors<br>• Semiconductors, conductors, & insulators<br>• N-Type & P-Type Semiconductors<br>• The PN Junction & The Diode | **2** |
| 3 | Diode Applications<br>• Half & Full Wave Rectifiers<br>• Power Supply filters | **2** |
| 4 | Special-Purpose Diodes<br>• Zener & Optical Diodes & their applications<br>• Finalize Power Supply Components | **1** |
| 5 | Bipolar Junction Transistors - BJT<br>• Transistor Construction & Basic Transistor Operation<br>• Transistor as an Amplifier & as a Switch | **3** |
| 6 | Transistor Bias Circuits<br>• DC Operating Point, Base, Emitter, & Collector Bias<br>• Voltage-Dividing Bias<br>• Small Signal Amplifiers | **2** |
| 7 | Advance Topics in Electronics<br>• Power Amplifiers<br>• Operation Amplifiers<br>• Oscillators & Timers | **2** |

***Class Schedule***:

- **Lecture:** Three 1.0 hour sessions per week
- **Lab**: Two 2.0 hours sessions per week

***Course Contribution to professional Component:***

- Engineering science: 100%
- Engineering design: 0%

***Course Relationship to Student Outcomes:***

| | *Student Outcomes* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***a*** | ***b*** | ***c*** | ***d*** | ***e*** | ***f*** | ***g*** | ***h*** | ***i*** | ***j*** | ***k*** |
| Educational Level | ***R*** | ***R*** | ***R*** | | | | ***I*** | | | | |

I: Introduce, R: Reinforce; & E: Emphasized

***Prepared By: Dr. Majdi Alnoaimi***

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Radiation Protection I** | **NE 351** | **351 هـ ن** | **3** | **-** | **-** | **3** |
| **Prerequisites** | | **NE 302** | | | | |
| Radioactivity, half-life, average life, serial transformation, interaction of radiation with matter. Radiation dosimetry: exposure measurements, absorbed dose measurements, exposure-dose relationship, specific gamma ray emission, internal dose calculations, dose commitment. Biological effects of radiation, dose limits, relative biological effectiveness (RBE), quality factor (QF) and dose equivalent. | | | | | | |

Faculties and departments requiring this course (if any): None

***Textbook:*** H. Cember and T. Johnson, Introduction to Health Physics. McGraw-Hill Medical; 4th edition (2008).

***Reference:*** M. G. Stabin, Radiation Protection and Dosimetry: An Introduction to Health Physics. Springer; 1st edition (2007).

***Course Learning Objectives: By 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

| NO | Topic Covered During Class: | Duration in Weeks |
|---|---|---|
| 1 | Radioactivity and Transformation Mechanism | **1** |
| 2 | Transformation Kinetics, half life, Activity, Specific Activity, Units. | **1** |
| 3 | Serial Transformation- Equilibrium of growth and decay. | **1** |
| 4 | Interaction of beta particles with matter, Mechanism of Energy loss | **1** |
| 5 | Interaction of alpha particles with matter, Mechanism of Energy loss | **1** |
| 6 | Gamma radiation-Exponential absorption, interaction mechanism, photoelectric, Compton effects and pair production. | **2** |
| 7 | Radiation dosimetry-Absorbed dose, Exposure, Exposure measurement,-Air well chamber, Free air chamber. | **2** |
| 8 | Exposure-dose relationship | **1** |
| 9 | Specific gamma ray emission. | **1** |
| 10 | Biological effects of radiation-Dose response characteristic, direct and indirect actions. | **1** |
| 11 | Radiation effects-Acute effects, Delayed effects, Genetic effects. | **1** |

***Class Schedule:***

- Lecture: Two 1.5 hour sessions per week
- Tutorials: Two 2.0 hours sessions per week

***Course Contribution to professional Component:***

- Engineering science: 100%
- Engineering design: 20%

***Course Relationship to Student Outcomes:***

| | *Student Outcomes* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***a*** | ***b*** | ***c*** | ***d*** | ***e*** | ***f*** | ***g*** | ***h*** | ***i*** | ***j*** | ***k*** |
| Educational Level | ***R*** | | | ***R*** | | ***I*** | | | ***R*** | | |

I: Introduce, R: Reinforce; & E: Emphasized

***Prepared By: Dr. Abdelrahim Kinsarah***

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Introduction To Medical Physics** | **NE 370** | **370 هـ ن** | **3** | **-** | **-** | **3** |
| **Prerequisites** | **NE 302** | | | | | |

The course focuses on medical imaging and therapy. The content will cover the Radiation Imaging by ionizing radiation such as X-Ray, Nuclear Medicine and non-ionizing radiation like Ultrasound Imaging and Magnetic Resonance Imaging (MRI). Radiation Therapy. Planning, treatment by linear accelerator, treatment by sealed and unsealed sources. Radiation Protection.

Faculties and departments requiring this course (if any): None

***Textbook***: E.B. Podgorzak, Radiation Oncology Physics: A Handbook for Teachers and Students. IAEA Library Cataloguing in Publication Data (2005).

***References:*** J. E. Bushberg, J. A. Seibert, E. M. Leidholdt J. R, and J. M. Boone, The Essential Physics of Medical Imaging Published. Lippncott Williams & Wilkens; 2nd edition (2002).
Faiz M. Khan, The Physics of Radiation Therapy. Lippincott Williams and Wilkins. 3rd edition (2003).

***Course Learning Objectives: By completion of the course, the students should be able to:***

1. Define the Medical Physics Field and responsibilities of a medical physicists
2. Define and describe the major Medical Physics subfields
3. Describe a radiation therapy system and break down into its main components, for each of the radiation therapy machines covered (Co-60, Linac, and Breakytherapy)
4. Describe an imaging system and break some of it down into its main components
5. Relates the interaction of charge particles & photons with matter in main therapeutic and diagnostic system machines
6. Describe scientific articles that relate to Medical Physics and be able to communicate their understanding in a professional manner
7. Learn to communicate the physical principles behind medical technology and relevant applications
8. Practice and apply elements of active learning, develop team norms and writing skills.
9. Describe how ideas from physics are integrated into medicine
10. See themselves as people who are more educated about Medical Physics than the average layperson
11. Able to inform and educate other intelligent citizen about the role of Medical Physics in personal and public life
12. Be excited about Medical Physics as a broad, complex, multifaceted field of study
13. Value the importance of precise language in the field of medical phyiscs work as part of professionalism
14. Be able how to read assigned materials responsibly.

| NO | Topic Covered During Class: | Duration in Weeks |
|---|---|---|
| 1 | Introduction to the Engineering of Medical Physics<br>Syllabus in details<br>Introduction to Medical Physics (Define field, subfield, responsibilities and roles) | 2 |
| 2 | Introduction to the Physics of Radiation Therapy<br>Basics Radiation Physics | 1 |
| 3 | Dosimetry Principles, Quantities and Units | 1 |
| 4 | Radiation Monitoring | 1.5 |
| 5 | Treatment Machines for External Beam Radiotherapy | 1.5 |
| 6 | External Photon Beams: Physics Aspects | 1 |
| 7 | Clinical Treatment Planning In External Photon Beam Radiotherapy | 1 |
| 8 | Electron Beams: Physical and Clinical Aspects | 1 |
| 9 | Introduction to the Physics of Medical Imaging<br>Physics of the Eyes and Vision | 1.5 |
| 10 | Introduction to Medical Imaging<br>Introduction to Radiation with Matter in Dx | 1.5 |
| 11 | Computers in Medical Imaging | 1 |

***Class Schedule:***

- Lecture: Two 1.5 hour sessions per week.
- Tutorials: None.

***Course Contribution to professional Component*:**

- Engineering science: 100 %
- Engineering design: 0 %

***Course Relationship to Student Outcomes:***

| | *Student Outcomes* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***a*** | ***b*** | ***c*** | ***d*** | ***e*** | ***f*** | ***g*** | ***h*** | ***i*** | ***j*** | ***k*** |
| Educational Level | | | | | | | ***E*** | ***R*** | ***R*** | | |

I: Introduce, R: Reinforce; & E: Emphasized

***Prepared By: Dr. Faud Abolaban***

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Anatomy and Physiology for Medical Physicists** | **NE 371** | **371 هـ ن** | **2** | **-** | **1** | **2** |
| **Pre-requisites** | | **BIO 110** | | | | |
| Introduction to human anatomy and physiology. Medical terminology of human organs and of human diseases. Understanding basic medical anatomy from 3D re-sliced medical images: Axial, Sagittal, Coronal, and oblique reformat and from 2D projections of medical data: anterior-posterior and posterior-anterior orientations. | | | | | | |

Faculties and departments requiring this course (if any): None

***Textbook:*** Heinz Feneis and Wolfgang Dauber, Atlas of Human Anatomy. Thieme Flexibook; $5^{th}$ edition (2000).

***Reference:*** J. Race, Medical Terminology with Human Anatomy. Prentice Hall; $5^{th}$ edition (2004).

***Course Learning Objectives: By completion of the course, the students should be able to:***

1. Explain the medical wording root, suffix, and prefix
2. Define all parts of the human body (directions)
3. Describe the human skin system
4. Describe the human skeletal and muscular systems
5. Describe the digestive and respiratory systems
6. Explain the structure of the Central Nervous System
7. Describe the cardiovascular system
8. Describe the morphology of the human urinary system
9. Explain the physiological process for the different human organs
10. Describe the different types of human cells and human glands

| ***NO*** | ***Topic Covered During Class:*** | ***Duration in Weeks*** |
|---|---|---|
| 1 | Description of how medical words are written and what are they consisted with examples that cover nearly the whole human body. | **1** |
| 2 | Common definition of patient orientations and directions | **1** |
| 3 | Human skin system. | **1** |
| 4 | Human bone skeletal & muscular systems | **2** |
| 5 | Human Digestive &respiratory systems | **2** |
| 6 | Human CNS system | **1** |
| 7 | Human cardiovascular system | **1** |
| 8 | Human urinary track system. | **1** |
| 9 | Physiology of the digestive, the respiratory, the urinary, and the cardiovascular organs | **3** |
| 10 | The different types of human cells and human glands | **2** |

***Course Schedule***

- Lecture: Two 1.0 hour sessions per week
- Tutorial: One 1.0 hour session per week

***Course Contribution to professional Component:***

- Engineering Science: 100 %
- Engineering Design: 0 %

***Course Relationship to Student Outcomes:***

| | *Student Outcomes* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***a*** | ***b*** | ***c*** | ***d*** | ***e*** | ***f*** | ***g*** | ***h*** | ***i*** | ***j*** | ***k*** |
| Educational Level | | | | | | ***R*** | ***R*** | | ***R*** | | |

I: Introduce, R: Reinforce; & E: Emphasized

***Prepared By: Dr. Abdalmajeid Alyassin***

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Radiobiology** | **NE 372** | **هـ ن 372** | **3** | **0** | **0** | **3** |
| **Prerequisites** | | **BIO 110, CHEM 281** | | | | |
| Physico-chemical aspects of interaction of ionizing radiation with the cell, radiation effects on macromolecules, cellular radiation biology, radiobiology of tissues and organs, cell survival curves, radiation biology as applied to radiation therapy, effects of radiation on the environment and man. | | | | | | |

Faculties and departments requiring this course (if any): None

***Textbook:*** E. J. Hall and A. J. Giacci, Radiobiology for the Radiologist. Lippincott Williams & Wilkins edition; 6th edition (2005).

***Reference:***K. N. Prasad, Handbook of Radiobiology. CRC Press; 2nd edition (1992).

***Course Learning Objectives: By completion of the course, the students should be able to*:**

1. Describe the various types of ionizing radiation
2. Define the main radiation quantities (units) used in the measurement of radiation levels
3. Describe the physical and chemical events that follow an ionizing event, including their spatial distribution, and the time scale
4. Define and give examples of direct and indirect effects of radiation
5. Describe the induced damage to the DNA and macromolecules
6. Describe the effect of radiosensitizers and radioprotectors
7. Construct a dose survival curve
8. Explain the practical aspects of dose fractionation in radiotherapy
9. Explain the radiation syndromes including: bone-marrow, gastrointestinal, central nervous system and hematopoietic syndromes
10. Discuss genetic effects of radiation and effects of radiation on embryogenesis
11. Describe the process leading to cancer
12. Explain the long term effects of radiation exposure, specifically as it relates to leukemia and other cancers, cataracts, Life shortening

| ***NO*** | ***Topic Covered During Class:*** | ***Duration in Weeks*** |
|---|---|---|
| 1 | Interaction of radiation with matter: | **1** |
| 2 | Absorption of energy | **1** |
| 3 | Radiation chemistry | **1** |
| 4 | Basic cell biology | **1** |
| 5 | Cellular radiation damage | **2** |
| 6 | Modification of cellular radiation damage | **1** |
| 7 | Molecular radiation biology | **1** |
| 8 | Repair of radiation damage | **1.5** |
| 9 | Radiation syndromes | **1.5** |
| 10 | Radiation carcinogenesis | **2** |
| 11 | Radiation induced genetic damage | **1** |

***Class Schedule***:

- Lecture: Two 1.5 hour sessions per week
- Tutorial: None

***Course Contribution to professional Component:***

- Engineering science: 100%
- Engineering design: 0%

***Course Relationship to Student Outcomes:***

| | *Student Outcomes* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***a*** | ***b*** | ***c*** | ***d*** | ***e*** | ***f*** | ***g*** | ***h*** | ***i*** | ***j*** | ***k*** |
| Educational Level | | | | | | ***R*** | ***R*** | | | | |

I: Introduce, R: Reinforce; & E: Emphasized

***Prepared By: Dr. Fathi Dhjouidar***

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Summer Training** | **NE 390** | **390 هـ ن** | **-** | **-** | **4** | **2** |
| **Prerequisites** | | **NE 340, NE 451** | | | | |
| Training is usually arranged at an industrial establishment under the supervision of a faculty member. Students have to submit a report regarding their achievements in addition to any other requirements as assigned by the department. | | | | | | |

Faculties and departments requiring this course (if any): None

***Textbook:*** Donald Dinero,Training Within Industry: with CDROM.Productivity Press; (2005).

***Reference:*** Health and Safety at Work: A Guide for Trainees (Engineering Training Guide) Training Publications Ltd; 2nd edition (1990).

***Course Learning Objectives: By completion of the course, the students should 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.

| ***NO*** | ***Topic Covered During Class:*** | ***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. | **2** |
| 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. | **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 Student Outcomes:***

| | *Student Outcomes* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***a*** | ***b*** | ***c*** | ***d*** | ***e*** | ***f*** | ***g*** | ***h*** | ***i*** | ***j*** | ***k*** |
| Educational Level | | | | ***R*** | | ***R*** | ***R*** | ***R*** | | ***R*** | |

I: Introduce, R: Reinforce; & E: Emphasized

***Prepared By: Dr. Dheya Othmani***

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| Radiation Protection II | NE 451 | هـ ن 451 | 3 | 2 | - | 4 |
| Prerequisites | | NE 351 | | | | |
| Radiation protection guides such as ICRP, NCRP etc. Radiation safety criteria, Allowable Limit on 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. | | | | | | |

Faculties and departments requiring this course (if any): None

***Textbook:*** H. Cember and T. Johnson, Introduction to Health Physics. McGraw-Hill Medical;4th edition (2008).

***Reference:*** G. F. Knoll, Radiation Detection and Measurements. John Wiley; 3rd edition (2000).

***Course Learning Objectives: By completion of the course, the students should be able to:***

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

| ***NO*** | ***Topic Covered During Class:*** | ***Duration in Weeks*** |
|---|---|---|
| 1 | Radiation protection guides such as ICRP, NCRP etc. | **1** |
| 2 | Radiation safety criteria, Annual Limit of Intake (ALI), Derived Air | **1** |
| 3 | Concentration (DAC) and Maximum Permissible concentration (MPC) | **2** |
| 4 | Health Physics instruments | **2** |
| 5 | Diagnostic and therapeutic x-ray shielding | **2** |
| 6 | Basic principles for external radiation protection | **2** |
| 7 | Basic principles for internal radiation protection | **2** |
| 8 | Radioactive waste management | **2** |

***Class Schedule:***

- Lectures: Two 1.5 hour sessions per week.
- Labs.: One 2.0 hour sessions per week.

***Course Contribution to professional Component***:

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

***Course Relationship to Student Outcomes:***

| | *Student Outcomes* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***a*** | ***b*** | ***c*** | ***d*** | ***e*** | ***f*** | ***g*** | ***h*** | ***i*** | ***j*** | ***k*** |
| Educational Level | ***R*** | ***E*** | ***E*** | ***E*** | | ***E*** | | ***E*** | | | |

I: Introduce, R: Reinforce; & E: Emphasized

***Prepared By: Dr. Fathi Dhjouidar***

<table>
<tr><th rowspan="2">Course Title</th><th rowspan="2">English Code /No</th><th rowspan="2">Arabic Code/No.</th><th colspan="4">Hours</th></tr>
<tr><th>Th.</th><th>Pr.</th><th>Tr.</th><th>Credit</th></tr>
<tr><td>Radiotherapy I</td><td>NE 470</td><td>470 هـ ن</td><td>3</td><td>2</td><td>-</td><td>4</td></tr>
<tr><td colspan="3">Prerequisites</td><td colspan="4">NE 370 & NE 371</td></tr>
<tr><td colspan="7">Dose and exposure calculations, patient dose calculation, treatment plans and use of computer in radiotherapy, treatment by linear accelerator and sealed and open sources.</td></tr>
</table>

Faculties and departments requiring this couzse (if any): None

***Textbook:*** F. M. Khan, The Physics of Radiation Therapy, Williams & Wilkins (2009).

***Reference:*** G. Bentel, Radiation Therapy Planning. McGraw-Hill Professional; 2nd edition (1995).

***Course Learning Objectives: By completion of the course, the students should be able to:***

1. Define precise technical information about radiotherapy machine.
2. Define the physical characteristics of photon & electron therapy beams.
3. Calculate the absorbed dose to cancer lesions.
4. Use calibration protocol for megavoltage beams
5. Lear the dose distribution in phantoms and human body.
6. Identify the dose calculation parameters
7. Differentiate between the dose delivered to regular & irregular fields.
8. Use the TPS for measurement and planning isodose curves.
9. Describe physical approach of the different types of radiation modulators.
10. Define precisely the radiotherapy terminology.
11. Explain combination of therapy fields with the patients.
12. Describe the ideal setup of the patient during radiation treatment.

| ***NO*** | ***Topic Covered During Class:*** | ***Duration in Weeks*** |
|---|---|---|
| 1 | Specification and technology of linac | 1 |
| 2 | Specification and technology of radionuclide therapy | 1 |
| 3 | Treatment planning technology | 2 |
| 4 | Calculation of absorbed dose in phantoms and patients | 2 |
| 5 | Absorbed dose calibration protocols for megavoltage beams | 2 |
| 6 | Dose distribution and scatter analysis<br>1- PDD<br>2- TAR<br>3- SAR | 3 |
| 7 | System of dosimetric calculations | 2 |
| 8 | Corrections for the absorbed dose to the patients | 1 |
| 9 | Radiation field combination | 1 |

***Class Schedule:***

- Lectures: Three 1.0 hour sessions per week.
- Labs: Two 2.0 hours session per week.

***Course Contribution to professional Component***:

- Engineering science: 100 %
- Engineering design: 0 %

***Course Relationship to Student Outcomes:***

| | *Student Outcomes* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***a*** | ***b*** | ***c*** | ***d*** | ***e*** | ***f*** | ***g*** | ***h*** | ***i*** | ***j*** | ***k*** |
| Educational Level | ***E*** | | | | ***E*** | | ***E*** | | | | |

I: Introduce, R: Reinforce; & E: Emphasized

***Prepared By: Dr. Foaud Abolaban***

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Medical Imaging I** | **NE 471** | **هـ ن 471** | **3** | **-** | **-** | **3** |
| **Prerequisites** | | **NE 370 & NE 371** | | | | |
| Introduction to medical image processing and medical image quality. Medical imaging modalities based on ionizing radiation. Physical principles and components of X-ray Radiography. X-ray spectrum and factors that affect its shape. Physical principles and components of X-ray Computed Tomography. Mathematical algorithms used to reconstruct CT and Nuclear Medicine images: Center Slice Theorem, Radon Transform, Filter Back-projection and iterative reconstruction techniques. Introduction to medical imaging modalities based on non ionizing radiation; such as MRI and US Imaging. | | | | | | |

Faculties and departments requiring this course (if any): None

***Textbook:*** J.E. Bushberg, J.A. Seibert, E.M. Leidholdt JR, and J.M. Boone, The Essential Physics of Medical Imaging. Lippncott Williams & Wilkens Editions; 2nd Edition (2002).

***Reference:*** P. Suetens, Fundamentals of Medical Imaging. Cambridge University Press; (2002).

***Course Learning Objectives: By completion of the course, the students should be able to*:**

1. Define the key factors that affect image quality
2. List, define, and explain an ionizing imaging system and break it down into its components and physical principles, for each of the imaging modalities covered (X-ray Radiography and
3. X-ray computed tomography)
4. Describe published scientific articles that relate to medical imaging and be able to communicate their understanding in a professional manner
5. Learn to communicate the physical principles behind medical technology and relevant applications
6. Describe basic components of the nuclear medicine imaging equip. such Gamma Camera, SPECT, and PET in addition to the image reconstruction techniques.
7. Describe basic components of the non-ionizing medical imaging equip. such MRI and US
8. Remember the terms associated with Medical Imaging
9. Remember the image quality parameters
10. Practice and apply elements of active learning, develop team norms and writing skills.
11. Able to critically evaluate bodies of literature in the medical imaging application
12. Integrate ideas from physics into medicine
13. See themselves as people who are more educated about medical imaging
14. Able to inform and educate other intelligent citizen about the role of medical imaging in personal and public life
15. Be excited about medical imaging as a broad, complex, multifaceted field of study

16. Value the importance of precise language in the field of medical imaging work as part of professionalism
17. Be able how to read assigned materials responsibly.

| *NO* | *Topic Covered During Class:* | *Duration in Weeks* |
|---|---|---|
| 1 | **Introduction to Digital Image Processing**<br>· Anatomy of the eye, Property of Light, Color Models, & Visual Illusions<br>· Definition of digital images; dynamic range, quantization, histogram<br>· Evaluation of image quality; resolution, contrast, noise, & artifacts | **1** |
| 2 | · Basic Image operations; gray level transformations, multi-image operations, geometric operations and linear and non-linear filters | **1** |
| 3 | · Introduction to Linear System Theory<br>· Introduction to Medical Imaging and Computers in Medical Imaging | **1** |
| 4 | **Diagnostic Radiographic Imaging**<br>· X-ray Machine, X-ray Tubes, Filters, Collimators, Grid, & Generators | **1.5** |
| 5 | · Image Receptors, Screen – Film Radiography, Image Intensifiers, Computed Radiography, Direct Radiography Detectors | **1.5** |
| 6 | · X-ray Production, Radiographic Charts, Factors Affecting X-ray Emission Spectra, Scatter Radiation, Image Quality, & Biological Effect & Safety. | **1.5** |
| 7 | **X-ray Computed Tomography Imaging – CT**<br>· Generations of X-ray CT: Machine Components, CT Image, CT Number | **1.5** |
| 8 | · Tomography, projection, Radon Transform, Sampling, Center Slice Theorem & Filter Back projection Reconstruction | **1.5** |
| 9 | · Types of CT, Spiral, Multi-slice CT, Pitch, Image Quality & Radiation Dose | **1.5** |
| 10 | **Nuclear Medicine Imaging – NM**<br>· NM imaging; Components, Choices of Radionuclide, Types of Image Reconstructions for Single Photon Emission Tomography (SPECT) & Positron Emission Tomography (PET).<br>Planner & Tomographic NM imaging & Clinical Applications in NM | **1** |
| 11 | **Non Ionizing Radiation Imaging Modalities**<br>· Introduction Magnetic Resonance Imaging – MRI<br>· Introduction to Ultrasonic Imaging – US | **1** |

***Class Schedule:***

- Lectures: Two 1.5 hour sessions per week.
- Tutorials: None.

***Course Contribution to professional Component:***

- Engineering science: 100 %
- Engineering design: 0 %

***Course Relationship to Student Outcomes:***

| | *Student Outcomes* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***a*** | ***b*** | ***c*** | ***d*** | ***e*** | ***f*** | ***g*** | ***h*** | ***i*** | ***j*** | ***k*** |
| Educational Level | | ***R*** | | ***R*** | | | ***E*** | | | | |

I: Introduce, R: Reinforce; & E: Emphasized

***Prepared By: Dr. Madji Alnoaimi***

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Nuclear Medicine** | **NE 472** | **هـ ن 472** | **3** | **-** | **-** | **3** |
| **Prerequisites** | | **NE 370, NE 451** | | | | |
| Production of radionuclide, radiopharmaceuticals, nuclear medicine instrumentations (NaI(Tl)) detector, well counter, Thyroid probe, dose calibrator, gamma camera, SPECT, and PET), quality control, clinical applications, internal radiation dosimetry, safe handling of radionuclides, and statistics of radiation counting. | | | | | | |

Faculties and departments requiring this course (if any): None

***Textbook:*** M. A. Wilson, Textbook of Nuclear Medicine. Lippincott Williams & Wilkins Editions (1998).

***Reference:*** F. Mettler and M. Guiberteau, Essentials of Nuclear Medicine Imaging. Saunders; 5th edition (2005).

***Course Learning Objectives: By completion of the course, the students should be able to:***

1. Define and explain difference between radionuclides and radiopharmaceuticals
2. Explain different methods for production of radiopharmaceuticals
3. Apply mathematical formulas to calculate radionuclides in the pharmaceuticals
4. Solve problems associated with the production methods of radiopharmaceuticals
5. Explain the physics of NaI (Tl) detector and gamma camera
6. Define and explain SPECT and its application in nuclear medicine imaging
7. Define and explain PET and its application in nuclear medicine imaging
8. Explain the purpose of well counter in the field of nuclear medicine
9. Explain the use of dose calibration in nuclear medicine
10. Discuss the use of thyroid probe in nuclear medicine
11. Define quality control in nuclear medicine, explain instrumentation quality control, and radiopharmaceutical quality control
12. Calculate thyroid uptake of radioisotopes
13. Discuss diagnosis and treatment of thyroid disease
14. Discuss radionuclide renal evaluation
15. Employ isotope dilution technique for the measurement of plasma volume
16. Compute dose and dose rate for internally deposited radioisotopes
17. Explain the principles of radiation protection and discuss the effect of time, distance, and shielding
18. Discuss different steps to avoid internal contamination
19. Discuss DOs and DON'Ts in radiation protection practice
20. Employ the idea of radiation counting statistics and propagation of errors to compute percentage uncertainty in nuclear medicine clinical applications

| ***NO*** | ***Topic Covered During Class:*** | ***Duration in Weeks*** |
|---|---|---|
| 1 | Radiopharmaceuticals and their production | 1 |
| 2 | NaI(Tl) detectors and gamma cameras | 1 |
| 3 | Well counter, thyroid probe, and dose calibrator | 1 |
| 4 | SPECT | 1 |
| 5 | PET | 1 |
| 6 | Quality control in nuclear medicine | 1 |
| 7 | Clinical applications | 1.5 |
| 8 | Internal radiation dosimetry | 1.5 |
| 9 | Safe handling of radionuclides | 1.5 |
| 10 | Statistics of radiation counting | 1.5 |

***Class Schedule:***

- Lectures: Two 1.5 hour sessions per week.
- Tutorials: One 2.0 hours session per week.

***Course Contribution to professional Component:***

- Engineering science: 100 %
- Engineering design: 0 %

***Course Relationship to Student Outcomes:*** **(a) & (g)**

***Course Relationship to Student Outcomes:***

| | *Student Outcomes* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***a*** | ***b*** | ***c*** | ***d*** | ***e*** | ***f*** | ***g*** | ***h*** | ***i*** | ***j*** | ***k*** |
| Educational Level | ***E*** | | | | | | ***R*** | | | | |

I: Introduce, R: Reinforce; & E: Emphasized

***Prepared By: Dr. Hamid Faraj***

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2">English Code /No</td><td rowspan="2">Arabic Code/No.</td><td colspan="4">Hours</td></tr>
<tr><td>Th.</td><td>Pr.</td><td>Tr.</td><td>Credit</td></tr>
<tr><td>Dosimetry</td><td>NE 473</td><td>473 هـ ن</td><td>3</td><td>-</td><td>-</td><td>3</td></tr>
<tr><td colspan="3">Prerequisites</td><td colspan="4">NE 451, NE 470</td></tr>
<tr><td colspan="7">Radiation exposure, radiation absorbed dose, dose units, kinetic energy absorbed in unit mass, dose equivalent, Bragg-Gray theory, measurement methods and detection by ionization chambers, proportional detectors and solid state detectors, Geiger tubes, TLD, calorimetric method, and scintillation detectors.</td></tr>
</table>

Faculties and departments requiring this course (if any): None

***<u>Textbook:</u>*** M. G. Stabin, Radiation Protection and Dosimetry: An Introduction to Health Physics. Springer; 1st edition (2010).

***<u>Reference:</u>***K. Arshak and O. Korostynska, Advanced Materials and Techniques for Radiation Dosimetry. Artech House Publishers; 1st edition(2006)

***<u>Course Learning Objectives: By completion of the course, the students should be able to:</u>***

1. Define and explain radiation exposure and its units
2. Define and explain radiation absorbed dose and its units
3. Derive the relationship between exposure rate and absorbed dose
4. Solve problems to compute exposure rate and absorbed dose rate for different types of radiation field
5. Explain the difference between Kerma and absorbed dose
6. Discuss different methods used for the measurement of exposure such as free ionization chamber and the air wall chamber (Thimle chamber)
7. Solve problems to compute exposure rate using the theory outlined in the measurement methods
8. Discuss different methods used for the measurement of absorbed dose such as calorimetric dosimeter and film badges
9. Define and explain Bragg-Gray principle for absorbed dose measurement
10. Solve problems using Bragg-Gray principle
11. Solve problems to compute dose and dose rate for external radiation sources
12. Solve problems to compute dose and dose rate for internally deposited radioisotopes
13. Explain and discuss gas filled detectors such as ionization chamber, proportional counter, and Geiger detectors
14. Explain and discuss scintillation detectors
15. Explain and discuss solid state detectors
16. Explain and discuss thermo-luminescent dosimeter (TLD) for dose measurement
17. Solve problems using the theory outlined in the above detectors/dosimeters

| NO | Topic Covered During Class: | Duration in Weeks |
|---|---|---|
| 1 | Exposure for x-rays and gamma rays | 1 |
| 2 | Absorbed radiation dose | 1 |
| 3 | Different dose units | 1 |
| 4 | Kerma and absorbed dose | 1 |
| 5 | Exposure-Dose relationship | 1 |
| 6 | Simple dosimeter model in terms of cavity theory | 1 |
| 7 | Exposure measurement-Free air | 1 |
| 8 | Exposure measurement-Thimble Chamber | 1 |
| 9 | Absorbed dose measurement- Calorimetric dosimeter | 1 |
| 10 | Absorbed dose measurement-Calorimetric dosimeter, Film Badges | 1.5 |
| 11 | Bragg-Gray theory for absorbed dose calculations | 1 |
| 12 | Computation of dose from external radiation sources | 1.5 |
| 13 | Computation of dose from internal radiation sources | 1.5 |
| 14 | Gas filled detectors-Ionization chamber, proportional counter, and Geiger counter | 1.5 |
| 15 | Scintillation detectors | 1 |
| 16 | Solid state detectors | 1 |
| 17 | TLD and film badges | 1.5 |

***Class Schedule:***

- Lectures: Three 1.0 hour sessions per week.
- Tutorials: One 3.0 hours session per week.

***Course Contribution to professional Component*:**

- Engineering science: 100 %
- Engineering design: 0 %

***Course Relationship to Student Outcomes:***

| | Student Outcomes | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***a*** | ***b*** | ***c*** | ***d*** | ***e*** | ***f*** | ***g*** | ***h*** | ***i*** | ***j*** | ***k*** |
| Educational Level | | | | | ***R*** | | ***R*** | | | | |

I: Introduce, R: Reinforce; & E: Emphasized

***Prepared By: Dr. Majdi Alnoaimi***

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Medical Imaging II** | **NE 474** | **474 هـ ن** | **3** | **2** | **-** | **4** |
| **Prerequisites** | | **NE 471** | | | | |

Evaluation techniques of medical images using ROC analysis, Contrast Detail curve, Rose Model, MTF, NPS, and DQE. Medical imaging modalities based on non-ionizing radiation. Physical principles and components of Magnetic Resonance Imaging. Intrinsic and Extrinsic parameters that affect the NMR and the MRI signal. Fundamental MRI pulse sequences. MRI gradient and image formation. Factors that affect MR image quality. Mathematical formulation, physical principles and components of Ultrasound Imaging. Advance applications of X-ray Radiography; such as Mammography, Fluoroscopy, and DSA.

Faculties and departments requiring this course (if any): None

***Textbook:*** J.E. Bushberg, J.A. Seibert, E.M. Leidholdt JR, and J.M. Boone, The Essential Physics of Medical Imaging. Lippncott Williams & Wilkens editions; $2^{nd}$ edition (2002).

***Reference:*** P. Suetens, Fundamentals of Medical Imaging. Cambridge University Press; (2002).

***Course Learning Objectives: By completion of the course, the students should be able to:***

1. Define the terms associated with Medical Imaging
2. Define the image quality parameters
3. Define and explain the key factors that affect image quality and address these factors for the different imaging modalities taught in class
4. List, define, explain and apply medical image evaluation techniques to assess the quality of medical images
5. Describe how the physical principles of the magnetic resonance imaging, Mammography, and Fluoroscopy imaging modalities
6. Describe the non ionizing imaging system and break it down into its components, for each of the imaging modalities covered (MRI, US);
7. Describe the physical principals occurring in MR pulse sequences such as spin echo, inversion recovery, gradient recall echo pulse sequences
8. Describe the difference between NMR and MRI
9. List and describe how the image quality parameters are affected in the non-ionizing imaging modalities
10. Describe some of the ionizing imaging system and break it down into its components, for each of the imaging modalities covered (Mammography & Fluoroscopy)
11. List and describe how the image quality parameters are affected in the ionizing imaging modalities
12. Communicate information published in scientific articles related to medical imaging
13. Communicate the physical principles behind medical technology and relevant applications
14. Practice and apply elements of active learning, develop team norms and writing skills.
15. Able to critically evaluate bodies of literature in the medical imaging application

16. Integrate ideas from physics into medicine
17. Educate others the role of medical imaging in personal and public life
18. Recognize and appreciate medical imaging as a broad, complex, multifaceted field of study
19. Practice precise language in the field of medical imaging as part of professionalism
20. Read assigned materials responsibly.

| ***NO*** | ***Topic Covered During Class:*** | ***Duration in Weeks*** |
|---|---|---|
| 1 | Description & Evaluation of Medical Images (Resolution, Noise, Contrast) | 1 |
| 2 | SNR, Weiner Spectra, & Modulation Transfer Function, Contrast Detail, Rose Model, & ROC Analysis | 1 |
| 3 | Non-ionization Radiation Imaging Modality – Magnetic Resonance Imaging (Magnetism and the Magnetic Property of Matter, Principles of Nuclear MR) | 1.5 |
| 4 | **NMR:**Tissue MR parameters **-** Spin, T1 and T2 , T2* relaxations, FID | 1.5 |
| 5 | **MRI:** Pulse Sequences-Spin echo, Inversion Recovery, GRE, Perfusion, & Diffusion. | 1 |
| 6 | **MRI:**MRI & Gradients: Slice, Frequency & Phase encoding, K-space & Image Quality | 1 |
| 7 | Clinical Applications of Diagnostic Radiographic Imaging (Mammography, Dedicated Equipments, Specialized X-ray Tubes, Optimized Image Receptor Systems, X-ray Tube, Target, Tube Port & Filtration, & Beam Quality, HVL, Collimation & Field Alignment, X-ray Generator, AEC, Compression, Scatter Radiation, MTF, Stereotactic Breast Biopsy, Radiation Dosimetry, Full Field Digital Mammography, SFM vs FFDM, Computer Aided Diagnoses, Quality Assurance and Quality Control) | 2 |
| 8 | Fluoroscopy (Image Intensifier Components & Characteristics Brightness Gain, Conversion Factor, DQE, Contrast Ratio, FOV, Artifacts of II, Video Camera & Resolution, Peripherals, Modes of Operations, ABC, Image Quality, Radiation Dose, & Fluoroscopy Suites) | 2 |
| 9 | Ultrasound Imaging*:* Physical Principles of Diagnostic Ultrasound, Instrumentation, and Operation | 1.5 |
| 10 | Ultrasound Imaging: acoustic waves, wave propagation in tissue, wave propagation, imaging and Doppler imaging, and scanning mode | 1.5 |

***Class Schedule:***

- Lectures: Two 1.5 hour sessions per week.
- Lab: 1 hour per week.

***Course Contribution to professional Component***:

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

***Course Relationship to Student Outcomes:***

| | *Student Outcomes* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***a*** | ***b*** | ***c*** | ***d*** | ***e*** | ***f*** | ***g*** | ***h*** | ***i*** | ***j*** | ***k*** |
| Educational Level | | ***E*** | | ***R*** | | | ***E*** | | | | ***E*** |

I: Introduce, R: Reinforce; & E: Emphasized

***Prepared By: Dr. Abdalmajeid Alyassin***

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| Practical Training | NE 489 | 489 هـ ن | - | - | 4 | 2 |
| Prerequisites | | NE 470 & NE 471 | | | | |
| Students of the Engineering Medical Physics Track are assigned practical clinical rotational training in different radiological departments at hospitals to familiarize the students with actual procedures and practices in the field of Medical Physics. | | | | | | |

Faculties and departments requiring this course (if any): None

***Textbook:*** AAPM Presidential Ad Hoc Committee on the Clinical Training of Radiological Physicists, Essentials and guidelines for hospital based medical physics residency training programs. (AAPM report);(1992)

***Reference:*** Douglas P. Beall, Radiology Sourcebook: A Practical Guide for Reference and Training. Humana Press; 1st edition (2010).

***Course Learning Objectives: By completion of the course, the students should be able to*:**

1. Identify the role of medical physicist in realistic profession environment.
2. Apply theoretical Medical Physics concepts
3. Use different equipment and technologies used in the field of Medical Physics.
4. Practice the professional and ethical behavior toward patients, physicians, and co-workers in the profession of Medical Physics.

| NO | Topic Covered During Class: | Duration in Weeks |
|---|---|---|
| 1 | Radiology clinical rotation | **4** |
| 2 | Nuclear Medicine clinical rotation | **4** |
| 3 | Radiotherapy clinical rotation | **4** |

***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 Student Outcomes:***

| | Student Outcomes | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***a*** | ***b*** | ***c*** | ***d*** | ***e*** | ***f*** | ***g*** | ***h*** | ***i*** | ***j*** | ***k*** |
| Educational Level | | | | ***R*** | | | ***E*** | | | ***R*** | |

I: Introduce, R: Reinforce; & E: Emphasized

***Prepared By: Dr. Majdi Alnoaimi***

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Senior Project** | **NE 499** | **499 هـ ن** | **3** | **2** | **-** | **4** |
| **Prerequisites** | | **NE 340, NE 451 Department's Consent** | | | | |

Application of engineering principles to a significant nuclear or radiation design project including team-work, written and oral communications. The project should also consider realistic technical, economic and safety requirements. The design project progresses step-by-step from the stages of problem definition, analysis and synthesis to design and tests. Students will deliver a final report and an oral presentation. This design project will involve a multi-disciplinary approach to the problem. Consultation from a business/industrial counterpart is highly recommended.

Faculties and departments requiring this course (if any): None

***Textbook:*** Bahattin Karagözoğlu, A Guide to Engineering Design Methodologies and Technical Presentation, Department of Electrical and Computer Engineering, Faculty of Engineering, KAU (2007).

***Reference:*** Assessment Rubrics for BS Projects, available from the BS Project Committee.Nuclear Engineering Department, Faculty of Engineering, KAU (2007).

***Course Learning Objectives: By completion of the course, 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

| ***NO*** | ***Topic Covered During Class:*** | ***Duration in Weeks*** |
|---|---|---|
| 1 | Project selection and team formation | 1 |
| 2 | Problem Definition | **2** |
| 3 | Literature review and data collection | **3** |
| 4 | Problem formulation:<br>• Knowledge integration<br>• Operational and realistic constraints<br>• Design objectives<br>• Evaluation criteria | **3** |
| 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** |

***Course Schedule:***
2 general audience oral presentations of 30 minutes each
***Course Contribution to professional Component:***

- Engineering science: 30%
- Engineering design: 70%

***__Course Relationship to Student Outcomes:__***

| | *Student Outcomes* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***a*** | ***b*** | ***c*** | ***d*** | ***e*** | ***f*** | ***g*** | ***h*** | ***i*** | ***j*** | ***k*** |
| Educational Level | ***E*** | ***E*** | ***E*** | ***E*** | ***E*** | ***E*** | ***E*** | ***E*** | ***E*** | ***E*** | ***E*** |

I: Introduce, R: Reinforce; & E: Emphasized

***__Prepared By: Dr. Abdalmajeid Alyassin__***

## Description of the Nuclear Engineering (Medical Physics)Program

### 1. Elective NE-MP Department Courses

| Course Code | Course Title |
|---|---|
| **Required Courses by the Nuclear Engineering Program** | |
| NE 303 | Energy and the environment |
| NE 304 | Introduction to Nuclear Engineering |
| NE 311 | Nuclear Reactor Analysis |
| NE 321 | Nuclear Heat Transport |
| NE 330 | Nuclear Materials |
| NE 360 | Radioisotope Applications I |
| NE 402 | Computational Methods in Nuclear Engineering |
| NE 411 | Thermal Reactor Dynamics and Kinetics |
| NE 450 | Radiation Shielding Design |
| **Other Required Courses by the Nuclear Engineering (Radiation Protection) Program** | |
| NE 307 | Experimental Data Analysis |
| NE 441 | Advanced Nuclear Radiation Measurements |
| NE 453 | Rules and Regulation of Nuclear Radiation |
| NE 454 | Environmental Radioactivity |
| NE 456 | Operational Radiation Protection |
| **Elective Courses to all the Nuclear Engineering Programs** | |
| NE 300 | Fundamentals of Nuclear Engineering Calculations |
| NE 350 | Non-Ionizing Radiations |
| NE 361 | Introduction to Non Destructive Testing and Visual Inspection |
| NE 452 | Technology of Radiation Equipment |
| NE 457 | Low Level Radioactive Waste Management |
| NE 460 | Radioisotope Applications II |
| NE 461 | Eddy Current Testing andMagnetic ParticleTesting |
| NE 462 | Ultrasonic Testing and Liquid Penetrant Testing |
| NE 463 | Industrial Radiography |
| NE 464 | Radioanalytical Techniques |
| NE 467 | Radiochemistry |
| NE 475 | Radiotherapy II |
| NE 478 | Quality Assurance of Medical Equipment |
| NE 492 | Special Topics in Radiation Protection Engineering (I) |
| NE 493 | Special Topics in Radiation Protection Engineering (II) |
| NE 494 | Special Topics in Engineering Medical Physics (I) |
| NE 495 | Special Topics in Engineering Medical Physics (II) |
| NE 496 | Special Topics in Nuclear Power Engineering (I) |
| NE 497 | Special Topics in Nuclear Power Engineering (II) |

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Fundamentals of Nuclear Engineering Calculations** | **NE 300** | **300 هـ ن** | **3** | **-** | **-** | **3** |
| **Prerequisites** | | **MATH 204, MATH 205** | | | | |
| 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. | | | | | | |

Faculties and departments requiring this course ( if any) : None

***Textbook***: E. Kreyszig, Advanced Engineering Mathematics. John Wiley & Sons; (2006).

***References:*** S. L. Ross, Differential Equations. John Wiley & Sons; (2003).
C. R. Wylie and L. C. Barratt, Advanced Engineering Mathematics. McGraw Hill; 6th edition (1995).

**Course Learning Objectives By completion of this 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 transform
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's function
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

| ***NO*** | ***Topic Covered During Class:*** | ***Duration in Weeks*** |
|---|---|---|
| 1 | Special Functions | **1** |
| 2 | Solutions of first order differential equations | **1** |
| 3 | Applications of first order differential equations | **1** |
| 4 | Solutions of second order & higher order differential equations | **2** |
| 5 | Applications of second order differential equations | **1** |
| 6 | Power series solution of differential equations | **1** |
| 7 | Solution of Bessel differential equation and Bessel function | **2** |
| 8 | Solution of Legendre equation and Legendre polynomials | **1** |
| 9 | Solution of differential eqs. Using Laplace transform | **1** |
| 10 | Fourier Series | **1** |
| 11 | Applications of Partial differential equations | **1** |
| 12 | Gauss's Divergence Theorem | **1** |

***Class Schedule:***
Lectures: Three 50 min. sessions per week.

***Course Contribution to professional Component***:

- Engineering science: 100 %
- Engineering design: 0 %
- Other 0 %

***Course Relationship to Student Outcomes:*** **(a) & (k)**

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Energy and the Environment** | **NE 303** | **303 هـ ن** | **2** | **-** | **-** | **2** |
| **Prerequisites** | | **PHYS 281** | | | | |
| Renewable and non-renewable energy resources including oil, coal, nuclear, hydro, solar, wind, and geothermal. Utilization, reserves, production, consumption and geographical distribution of energy sources. Environmental and economic implications of energy production and utilization. Energy conservation and policies. | | | | | | |

Faculties and departments requiring this course (if any): None

***Textbook:*** A. Maheshwari and G. Parmar, A Textbook of Energy, Ecology, Environment and Society. Anmol Publications Pvt Ltd; (2004).

***Reference:*** R. Wolfson, Energy Environment and Climate. W. W. Norton & Company; 1st edition(2008).

***Course Learning Objectives: By completion of the course, the students should be able to:***

1. Define energy efficiency.
2. Describe Nuclear energy.
3. Describe nuclear energy economy, environmental impact and limitations.
4. Describe oil and gas energy and world resources
5. Oil and gas energy economy, environmental impact and limitations.
6. Describe world resources of coal, its economy, environmental impact and limitations.
7. Describe solar- thermal energy system, their economy and limitations
8. Describe solar voltaic cells economy and limitations
9. Describe wind energy economy and limitations
10. Describe biomass, tidal and other sources of energies economy and limitations

| ***NO*** | ***Topic Covered During Class:*** | ***Duration in Weeks*** |
|---|---|---|
| 1 | Nuclear energy | **2** |
| 2 | Oil and gas | **2** |
| 3 | Coal energy | **2** |
| 4 | Solar thermal | **1** |
| 5 | Solar voltaic | **1** |
| 6 | Wind energy | **2** |
| 7 | Other sources of energy | **2** |
| 8 | Energy reports | **1** |
| 9 | Review | **1** |

***Class Schedule:***

- **Lecture**: Two 1.0 hour sessions per week
- **Tutorials**: One 1.0 hours sessions per week

***Course Contribution to professional Component:***

- Engineering Science: 100 %
- Engineering Design: 0 %

***Course Relationship to Student Outcomes:*** **(g), (h), & (j)**

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Introduction to Nuclear Engineering** | **NE 304** | **304 هـ ن** | **3** | **-** | **-** | **3** |
| **Prerequisites** | | **NE 302** | | | | |
| Application of radioactive decay equations, energy from fission and fuel burnup, 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. | | | | | | |

Faculties and departments requiring this course (if any): None

***Textbook:*** J.R. Lamarsh and A.J. Baratta, Introduction to Nuclear Engineering. Prentice Hall; 3rd edition (2001).

***Reference:*** J. K. Shultis and R. E. Faw, Fundamentals of Nuclear Science and Engineering. CRC Press 2nd edition (2007).

***Course Learning Objectives: By 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.

| *NO* | *Topic Covered During Class:* | *Duration in Weeks* |
|---|---|---|
| **1** | Decay Law, $T_{1/2}$, $T_{av.}$, $T_E$, Activity, units, Compound decay | **1** |
| **2** | Radioactive Equilibrium, $^{14}C$ dating, $^{238}U$ & $^{40}K$ dating, Neutron Activation, Problems | **1** |
| **3** | Nuclear Reactions, Nuclear Fissions, Energy Calculations. | **1** |
| **4** | Cross-section for nuclear reactions, reaction rates. | **1** |
| **5** | Nuclear fuel performance, problems. | **1** |
| **6** | Nuclear Reactors, Components of Nuclear reactors, Cladding. | **1** |
| **7** | Reactor Materials, Multiplication factor. | **1** |
| **8** | Criticality calculation. | **1** |
| **9** | Heat sources in Reactor system, Reactor power. | **1** |
| **10** | Diffusion of neutrons, diffusion equation. | **1** |
| **11** | Neutron migration (slowing down), Problems. | **1** |
| **12** | Reactor radiation sources, Reactor shielding. | **1** |
| **13** | Shielding calculations. | **1** |

***Class Schedule:***

- **Lecture**: two 1:30 hour sessions per week
- **Tutorial**: one three hours session per week

***Course Contribution to professional Component:***

- Engineering science: 100%
- Engineering design: 0%

***Course Relationship to student Outcomes: (a), (e), & (g)***

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Experimental Data Analysis** | **NE 307** | **307 هـ ن** | **2** | **-** | **-** | **2** |
| **Prerequisites** | | **IE 331** | | | | |
| Binomial distribution, Poisson distribution, normal distribution, linear and non-linear fitting, error distribution, Chi square test, F test, Statistical data processing. Application to radiation Protection and Medical Physics. | | | | | | |

Faculties and departments requiring this course (if any): None

***Textbook:***J. Antony, Design of Experiments for Engineers and Scientists. Butterworth Heinemann; 1st edition (2003).

***Reference:***D. C. Montgomery, Design and Analysis of Experiments. Wiley; 7th edition (2008).

***Course Learning Objectives: By completion of the course, the students should be able to:***

1. Define data and range.
2. State the procedure for finding the range of a set of numbers.
3. Compute the range of a set of numbers.
4. Apply range procedures to solve problems.
5. Describe the characteristics and differences between simple random sampling stratified random sampling,
6. Measure minimum detection limits and then estimate means and variances for censored data
7. Apply appropriate methods for detecting and estimating trends and seasonality in datasets
8. Recognize the importance (and limitations) of statistics in scientific research.
9. Describe the characteristics and limitations of research data.
10. Calculate and interpret 1 and 2-sample tests of mean and variance.
11. Construct, analyze, and interpret simple and multiple linear regression models.
12. Apply time series for analysis and forecasting
13. Identify distributions of variables using goodness of fits tests and other statistics
14. Apply appropriate transformations for normalizing data
15. Apply linear regression to develop predictive models for health indices and environmental data
16. Apply statistical tests to detect autocorrelation in regression models and use appropriate methods to handle autocorrelation in regression.
17. Apply conditional logistic regression to develop predictive models for health indices and environmental data.

18. Apply Poisson regression to develop predictive models for health indices and environmental data

| *NO* | *Topic Covered During Class:* | *Duration in Weeks* |
|---|---|---|
| 1 | Random Variables | **1** |
| 2 | Probability Theory | **2** |
| 3 | Data characterization | **1** |
| 4 | Probability Distributions | **1** |
| 5 | Statistical model; Binomial distribution, Poisson distribution, and normal distribution | **2** |
| 6 | Application of statistical models | **3** |
| 7 | Error propagation | **2** |
| 8 | Optimization of counting experiments | **1** |
| 9 | Limits of detestability | **1** |

***Class Schedule:***

- Lecture: Two 1 hour sessions per week
- Tutorials: One 2 hours session per week

***Course Contribution to Professional Component:***

- Engineering science: 100%
- Engineering design: 0 %

***Course Relationship to Student Outcomes: (a) & (i)***

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Nuclear Reactor Analysis** | **NE 311** | **311 هـ ن** | **3** | **-** | **-** | **3** |
| **Prerequisites** | | **NE 302** | | | | |
| The fission chain reaction. Nuclear fuels. Nuclear reactors and their components. Neutron flux. Diffusion equation. Neutron moderation. One group diffusion equation and criticality calculations. Reflected reactors. Multi-group calculations and heterogeneous reactors. | | | | | | |

Faculties and departments requiring this course (if any): None

***<u>Textbook</u>***J.R. Lamarsh and A.J. Baratta, Introduction to Nuclear Engineering. Prentice Hall; 3rd edition (2001).

***<u>Reference</u>*** W. M. Stacey, Nuclear Reactor Physics. Wiley-VCH; 2nd edition (2007).

***<u>Course Learning Objectives: By completion of the course, the students should be able to:</u>***

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

| *NO* | *Topic Covered During Class:* | *Duration in Weeks* |
|---|---|---|
| 1 | Fission chain reaction | **1** |
| 2 | Nuclear reactors and their components | **2** |
| 3 | Neutron flux | **2** |
| 4 | Diffusion equations | **2** |
| 5 | Neutron moderation | **2** |
| 6 | One group diffusion equation and criticality calculations | **2** |
| 7 | Reflected reactors | **1** |
| 8 | Multi-group calculations and heterogeneous reactors | **2** |

***Class Schedule:***

- Lecture: Three 1 hour sessions per week
- Lab: one 3 hours session per week

***Course Contribution to Professional Component:***

- Engineering Science: 100 %
- Design : 0 %

***Course Relationship to Student Outcomes:*** **(a), (c), (g), (i), & (k)**

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Nuclear Heat Transport** | **NE 321** | **هـ ن 321** | **4** | **-** | **-** | **4** |
| **Prerequisites** | | **NE 311, MEP 261** | | | | |
| 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. | | | | | | |

Faculties and departments requiring this course (if any): none

***Textbook:*** N. E. Todreas and M. Kazimi, Nuclear Systems Volume I: Thermal Hydraulic Fundamentals. Taylor & Francis; $2^{nd}$ edition (1989).

***Reference:*** Y. Cengel and M. Boles, Thermodynamics: An Engineering Approach. McGraw-Hill Science; $6^{th}$ edition (2006).

***Course Learning Objectives: By completion of the course, the students should be able to:***

1. 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.

| *NO* | *Topic Covered During Class:* | *Duration in Weeks* |
|---|---|---|
| 1 | Review, Atomic and nuclear structure and reactions | **1** |
| 2 | Review, Neutron flux distribution in cores | **1** |
| 3 | Reactor heat generation | **2** |
| 4 | Heat conduction in reactor elements; General and 1D SS | **3** |
| 5 | Heat conduction in reactor elements; Some special 1D SS | **2** |
| 6 | Heat conduction in reactor elements; 2D steady state cases | **1** |
| 7 | Heat transfer with change in phase | **2** |
| 8 | Two phase flow | **1** |
| 9 | The boiling core | **1** |

***Class Schedule***:

- Lecture: Two 1.5 Hour sessions per week
- Tutorials: Two 2.0 Hours sessions per week

***Course Contribution to professional Component***

- Engineering Science: 100 %
- Engineering Design: 0 %

***Course Relationship to Student Outcomes:*** **(a), (c), (e), (g), (i), (j), & (k)**

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Nuclear Materials** | **NE 330** | **هـ ن 330** | **3** | **-** | **-** | **3** |
| **Prerequisites** | | **NE 311, ChE 210** | | | | |
| The role of materials in reactors. Components of a nuclear reactor: fuel, reflector, coolant, structure, shielding, moderator, cladding and control rod materials. Fuel materials including uranium, plutonium and thorium. Radiation effects theory. Radiation effects on different reactor materials including structural metals, ceramics and organics. | | | | | | |

Faculties and departments requiring this course (if any): none

***Textbook:*** Selected Nuclear Materials and Engineering Systems, Materials Science International Team MSIT, Springer; 1st edition (2007).

***Reference:*** W. M.Bowen, C. A. Bennett, Statistical methods for nuclear material management, Nuclear Regulatory Commission. Washington, DC, USA (1988).

***Course Learning Objectives: By 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. Describe 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. Identify radiation damage picture of uranium in reactors.
9. Explain 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. Present crystal structure outlines, and radiation damage to some nuclear structural materials.

| *NO* | *Topic Covered During Class:* | *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. | **2** |
| 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. | **2** |
| 10 | Structural metals; Aluminum, Zirconium, and stainless steel. | **1** |
| 11 | Ceramics and cermets; structure, mechanical properties, thermal properties, manufacturing, and radiation damage. | **1** |
| 12 | Nuclear fuel elements. | **1** |

***Course Schedule:***

- Lecture: Three 1.0 hour sessions per week
- Tutorials: one 2.0 hours session per week

***Course Contribution to professional Component:***

- Engineering science: 100%
- Engineering design: 0%

***Course Relationship to Student Outcomes:*** **(a), (g), & (j)**

<table>
<tr><th rowspan="2">Course Title</th><th rowspan="2">English Code /No</th><th rowspan="2">Arabic Code/No.</th><th colspan="4">Hours</th></tr>
<tr><th>Th.</th><th>Pr.</th><th>Tr.</th><th>Credit</th></tr>
<tr><td>Non-ionizing Radiations</td><td>NE 350</td><td>350 هـ ن</td><td>3</td><td>-</td><td>-</td><td>3</td></tr>
<tr><td colspan="3">Prerequisites</td><td colspan="4">NE 302</td></tr>
<tr><td colspan="7">Physics of wave motion, Health effects of sound and ultrasound, Response spectra for physical agents, Electric current and electrocution, Static and low frequency electric and magnetic fields, Radiofrequency and microwave fields, Radiometric and photometric units for optical measurements, Ocular Effects of Visible Light, Lasers and laser safety, Health effects of ultraviolet radiation.</td></tr>
</table>

***Textbook:*** R. T. Hitchcock, R. M. Patterson, Radiofrequency and ELF Electromagnetic Energies: A Handbook for Health Professionals. Van Nostrand Reinhold; (1995).

***References:*** H. Cember and T. Johnson, Introduction to Health Physics. Mc Graw Hill; 4th edition (2009)

P. Polk and E. Postow, eds. Handbook of Biological Effects of Electromagnetic Fields. CRC; 2nd edition (1996).

***Course Learning Objectives: By completion of the course, the students should be able to*:**

1. Show knowledge of the different physical agents: noise, ultrasound, electric current, low frequency electric and magnetic fields, radiofrequency/microwave fields, visible light, lasers and ultraviolet radiation.
2. Analyze the factors determining absorption rates of electromagnetic radiation by the human body
3. Describe the biological effects of the non ionizing radiation on human beings
4. Evaluate physical and biological hazards of non ionizing radiation on humans
5. Determine the applicable standards for UV light, lasers, radio frequency radiation and static magnetic and electric fields
6. Apply wherever possible, common physical and biological concepts to the treatment of the various physical agents.
7. Recommend basic hazard controls including safe work practices, training

| *NO* | *Topic Covered During Class:* | *Duration in Weeks* |
|---|---|---|
| 1 | Show knowledge of the different physical agents: noise, ultrasound, electric current, low frequency electric and magnetic fields, radiofrequency/microwave fields, visible light, lasers and ultraviolet radiation. | 3 |
| 2 | Analyze the factors determining absorption rates of electromagnetic radiation by the human body | 2 |
| 3 | Describe the biological effects of the non ionizing radiation on human beings | 2 |
| 4 | Evaluate physical and biological hazards of non ionizing radiation on humans | 2 |
| 5 | Determine the applicable standards for UV light, lasers, radio frequency radiation and static magnetic fields | 2 |
| 6 | Apply wherever possible, common physical and biological concepts to the treatment of the various physical agents. | 2 |
| 7 | Recommend basic hazard controls including safe work practices, training | 2 |

***Class Schedule:***

- Lectures: Two 1.0 hour sessions per week.
- Tutorials: One 1.0 hour session per week.

***Course Contribution to professional Component***:

- Engineering science: 30 %
- Engineering design: 0 %
- Other 70 %

***Course Relationship to Student Outcomes:*** **(a) & (e)**

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Radioisotope Applications I** | **NE 360** | **360 هـ ن** | **3** | **1** | **-** | **3** |
| **Prerequisites** | | **NE 340** | | | | |
| Natural and artificial radioisotope production of radioisotopes, radiotracing. Selection of radioisotopes. Radiotracing applications. Radiography application with alpha and beta particles. Radiography applications with gamma rays. | | | | | | |

Faculties and departments requiring this course (if any): None

***Textbook***: G. A. Johansen and P. Jackson, Radioisotope Gauges for Industrial Process Measurements. Wiley; 1st edition (2004).

***Reference:*** G.Foldiak, Industrial Application of Radioisotopes. Elsevier (1986).

***Course Learning Objectives: By 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.

| NO | Topic Covered During Class: | Duration in Weeks |
|---|---|---|
| **1** | Production of Radioisotopes | **1** |
| **2** | Radio-Tracing Principles and Techniques | **1** |
| **3** | Radio-Tracer Applications | **2** |
| **4** | Radio-gauging principles and techniques | **1** |
| **5** | Radio-gauging with charged particles | **2** |
| **6** | Radio-gauging with EM radiation | **2** |
| **7** | Radio-gauging with neutrons | **2** |
| **8** | Radiography | **2** |
| **9** | Miscellaneous Applications of radioisotopes | **2** |

***Class Schedule:***

- Lecture: Two 1.5 hour sessions per week
- Tutorials: Two 2.0 hours sessions per week

***Course Contribution to professional Component:***

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

***Course Relationship to Student Outcomes:*** **(b), (e), & (g)**

<table>
<tr><th rowspan="2">Course Title</th><th rowspan="2">English Code /No</th><th rowspan="2">Arabic Code/No.</th><th colspan="4">Hours</th></tr>
<tr><th>Th.</th><th>Pr.</th><th>Tr.</th><th>Credit</th></tr>
<tr><td>Introduction to Non Destructive Testing and Visual Inspection</td><td>NE 361</td><td>361هـ ن</td><td>3</td><td>1</td><td>-</td><td>3</td></tr>
<tr><td colspan="2">Prerequisites</td><td colspan="5">ChE 210</td></tr>
<tr><td colspan="7">NON DESTRUCTIVE TESTING: Importance of NDT, Non-destructive testing: applications and tendencies, Defects detection principles, Various techniques of NDT: Liquid penetrant, Magnetic leakage, Eddy Currents, Radiography, Ultrasounds, Case studies for various industrial applications<br>VISUAL INSPECTION: Visual inspection principles, Visual inspection of welded components, Testing techniques, Inspection characteristics, Case studies (welding, casting, ..), Standards.</td></tr>
</table>

Faculties and departments requiring this course (if any): none

***Textbook:*** X. E. Gros, Applications of NDT Data Fusion. Springer; 1st edition (2001).

***Reference:*** P. E. Mix von John, Introduction to Non destructive Testing: A Training Guide, Wiley & Sons; (2005).

***Course Learning Objectives:*** By completion of the course, the students should be able to:

1. understand the application of nondestructive techniques in general
2. know the advantages and the limits non destructive techniques
3. Importance of standards, technical specifications, and test procedures
4. test some important industrial components such as welded and cast samples by visual inspection
5. record the test results
6. take a decision: acceptance or rejection by evaluating the test results according to the related standards (ASME, EN, etc.)

| ***NO*** | ***Topic Covered During Class:*** | ***Duration in Weeks*** |
|---|---|---|
| 1 | Importance of NDT, Non-destructive testing: applications and tendencies, | **2** |
| **2** | Defects detection principles, Various techniques of NDT, Optical processes, processes use, | **2** |
| **3** | Liquid penetrant, Magnetic leak flow processes, | **2** |
| **4** | Eddy Currents, Ultrasounds | **2** |
| **5** | Radiography, | **2** |
| 6 | **VISUAL INSPECTION:** Visual inspection principles, Welding processes, Welded assemblies' quality | **2** |
| 7 | The testing techniques, Inspection characteristics, The welding main processes, Standards application. | **2** |

***Course Schedule:***

- Lecture: Three 1.0 hour sessions per week
- lab: one 3.0 hours session per week

***Course Contribution to professional Component:***

- Engineering science: 100%
- Engineering design: 0%

***Course Relationship to Student Outcomes:*** **(b), (g), & (k)**

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Computational Methods in Nuclear Engineering** | **NE 402** | **402 هـ ن** | **3** | **1** | **-** | **3** |
| **Prerequisites** | | **EE 332, NE 321** | | | | |
| Introduction to numerical methods commonly encountered in Nuclear Engineering calculations, finite differencing, explicit and implicit techniques, convergence and stability criteria. Application of the above techniques to one group diffusion equation, multigroup diffusion equation, coupled diffusion equation with delayed neutrons, heat conduction and convection, criticality search method. Generation of heterogeneous cross-sections. | | | | | | |

Faculties and departments requiring this course (if any): None

***Textbook:***S. Nakamura, Computational Methods in Engineering and Science. J. Wiley & Sons; (1996).

***Reference:*** W.F. Miller, Computational Method of Books: Neutron Transport. John Wiley & Sons; (1984).

***Course Learning Objectives: By completion of the course, the students should be able to:***

1. Compare between deterministic and probabilistic numerical methods
2. Describe the computer methods for eigen values problem solving
3. Discuss different types of numerical solution techniques
4. Compare between numerical methods that used to solve neutron transport problems
5. Describe variance reduction techniques
6. Describe MCNP method and its sampling methods
7. Analyze of different methods that used in solving 1D neutron transport
8. Analyze and compare between error reduction techniques

| *NO* | *Topic Covered During Class:* | *Duration in Weeks* |
|---|---|---|
| 1 | Fundamentals of numerical analysis<br>• Deterministic and Probabilistic Methods<br>• Numerical solution of neutron transport/diffusion equation<br>• Discretization in time, energy, angle and space | **2** |
| 2 | Computer solutions for 1D eigen value problems<br>• Iterative computational methods for solving partial differential equations<br>• Finite element methods,<br>• Finite difference method,<br>• Coarse-mesh rebalancing method | **2** |
| 3 | Neutron Transport Equation in 1D:<br>• Numerical Solution of integro-Differential Equation<br>• Spatial discretization in slab geometry | **2** |
| 4 | Collision probability and Monte Carlo methods<br>• Continuous and discrete probability distribution<br>• Probability density function<br>• Cumulative probability distribution function Random numbers<br>• Categories of random sampling<br>• Importance sampling<br>• Variance reduction methods | **2** |
| 5 | Monte Carlo simulation of neutron transport<br>• Sampling of the position, direction, distance to collision<br>• type of collision | **3** |
| 6 | Sampling of energy and angle in Compton scattering<br>• Definitions of true and sample mean, variance, standard deviation<br>• Central limit theorem. Collision and track length estimators for flux calculation. | **2** |

***Course Schedule:***

- Lecture: Three 1.0 hour sessions per week
- Tutorials: Two 1.0 hour sessions per week

***Course Contribution to professional Component:***

- Engineering science: 100 %
- Engineering design: 0 %

***Course Relationship to Student Outcomes:*** **(c ), (e), (g), (i), (j), & (k)**

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Thermal Reactor Dynamics and Kinetics** | **NE 411** | **411 هـ ن** | **3** | **-** | **-** | **3** |
| **Prerequisites** | | **NE 311** | | | | |
| Reactor kinetics, effect of delayed neutrons, reactor control by control rods and chemical shim methods, temperature effects on reactivity and fission products poisoning. | | | | | | |

Faculties and departments requiring this course (if any): None

***<u>Textbook:</u>*** W. M. Stacey, Nuclear Reactor Physics.Wiley-Interscience; 1$^{st}$ edition (2001).

***<u>Reference:</u>*** D. L. Hetrick, Dynamics of Nuclear Reactors. American Nuclear Society; (1993)

***<u>Course Learning Objectives: By completion of the course, the students should be able to:</u>***

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

| NO | Topic Covered During Class: | Duration in Weeks |
|---|---|---|
| 1 | Classification of time problems | **1** |
| 2 | Prompt neutron lifetime | **1** |
| 3 | Reactor with no delayed neutrons | **1** |
| 4 | Reactor with delayed neutrons | **1** |
| 5 | The prompt critical state | **1** |
| 6 | The prompt jump or drop | **1** |
| 7 | Small Reactivity | **1** |
| 8 | Control rods and chemical shim and their reactivity worth | **1** |
| 9 | Reactivity coefficients, Temperature coefficient | **1** |
| 10 | Moderator coefficient | **1** |
| 11 | Void coefficient | **1** |
| 12 | Fission product poisoning | **1** |
| 13 | Equilibrium Xenon | **1** |
| 14 | Xenon after shutdown and reactor dead time | **1** |

***Class Schedule:***

- Lectures: Tow lectures of 1.5 hours sessions per week.
- Tutorials: Two 1.0 hours sessions per week.

***Course Contribution to professional Component***:

- Engineering science: 100%
- Engineering design: 0 %

***Course Relationship to Student Outcomes:*** **(a), (e), (g), & (k)**

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Radiation Shielding Design** | **NE 450** | **450 هـ ن** | **3** | **-** | **-** | **3** |
| **Prerequisites** | | **NE 451, EE 332** | | | | |
| 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. | | | | | | |

Faculties and departments requiring this course (if any): None

***<u>Textbook:</u>*** J. K. Shultis and R. E. Faw, Radiation Shielding. American Nuclear Society; (2000).

***<u>Reference:</u>*** G. F. Knoll, Radiation Detection and measurements. John Wiley; 3rd edition (2000).

***<u>Course Learning Objectives: By completion of the course, the students should be able to:</u>***

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.

| *NO* | *Topic Covered During Class:* | *Duration in Weeks* |
|---|---|---|
| 1 | Review of gamma and neutron radiation interaction | **1** |
| 2 | Introduction to gamma ray shielding, meanings of exposure & dose, direct & scattered radiation | **1** |
| 3 | Good geometry attenuation, broad beam attenuation, build-up factor. | **1** |
| 4 | Gamma point source shielding | **1** |
| 5 | Gamma ray line source shielding | **1** |
| 6 | Gamma ray planar source shielding | **1** |
| 7 | Internal source shielding | **1** |
| 8 | Gamma ray multi-layer shielding | **1** |
| 9 | Removal cross-section, Neutron removal in water and by flat attenuator | **1** |
| 10 | Neutron shielding | **1** |
| 11 | Nuclear reactor shielding | **1** |
| 12 | Neutron generator shielding, X-ray shielding | **1** |
| 13 | Shielding X-rays -Primary shielding | **1** |
| 14 | X-ray secondary radiation shielding | **1** |

***Class Schedule:***

- Lectures: Three 1.0 hour sessions per week.
- Tutorials: Two 1.0 hour sessions per week.

***Course Contribution to professional Component***:

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

***Course Relationship to Student Outcomes:*** **(c), (e), (g), (h), (i), & (k)**

<table>
<tr><th rowspan="2">Course Title</th><th rowspan="2">English Code /No</th><th rowspan="2">Arabic Code/No.</th><th colspan="4">Hours</th></tr>
<tr><th>Th.</th><th>Pr.</th><th>Tr.</th><th>Credit</th></tr>
<tr><td>Nuclear Power Planning & Project Implementation</td><td>NE 422</td><td>422 هـ ن</td><td>3</td><td>-</td><td>-</td><td>3</td></tr>
<tr><td colspan="3">Prerequisites</td><td colspan="4">NE 311</td></tr>
<tr><td colspan="7">Methods of long-range forecasting of power demand, calculations of cost of generation of electricity from nuclear and conventional power plants, selection of an optimum system expansion program, preparation of feasibility studies, bid documents and evaluation of bids, type of contracts, project management and use of available nuclear power planning computer codes.</td></tr>
</table>

Faculties and departments requiring this course (if any): none

***Textbook:***Consideration to Lunch a Nuclear Power Program. IAEA; (2007).

***Reference:***Harry Henderson, Nuclear Power: A Reference Handbook. ABC-CLIO edition; (2000).

***Course Learning Objectives: By completion of the course, the students should be able to:***

1. Discuss management organization
2. Review feasibility studies
3. Discuss sitting of power plants
4. Discuss human resources development,
5. Discuss societal problems associated with the choice of nuclear power energy over other sources of energy
6. Describe emergency plans

| *NO* | *Topic Covered During Class:* | *Duration in Weeks* |
|---|---|---|
| 1 | Methods of long-range forecasting of power demand | **2** |
| 2 | Calculations of cost of generation of electricity from nuclear and conventional power plants | **2** |
| 3 | Selection of an optimum system expansion program | **2** |
| 4 | type of contracts | **2** |
| 5 | Preparation of feasibility studies, bid documents and evaluation of bids | **3** |
| 6 | Project management and use of available nuclear power planning computer codes. | **2** |

***Class Schedule:***

- **Lecture**: Two 1.0 hour sessions per week
- **Tutorials**: One 1.0 hours sessions per week

***Course Contribution to professional Component:***

- Engineering Science: 80 %
- Engineering Design: 20 %

***Course Relationship to Student Outcomes:*** **(b), (c), (e), (f), & (g)**

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Nuclear Reactor Safety** | **NE 423** | **423 هـ ن** | **3** | **-** | **-** | **3** |
| **Prerequisites** | | **NE 321, NE 411** | | | | |
| Safety philosophies and safety criteria, design criteria and regulations, deterministic and probabilistic models, risk assessment, reactor accidents, engineering safety features, release and dispersal of radioactive materials and radiological consequences, reactor licensing. | | | | | | |

Faculties and departments requiring this course (if any): none

***Textbook:***D. G. Cacuci, Nuclear Reactor Safety Systems. Woodhead Publishing Ltd; (2011).

***Reference:*** G. Keßler, Sustainable and Safe Nuclear Fission Energy: Technology and Safety of Fast and Thermal Nuclear Reactors (Power Systems). Springer; 1st Edition, (2011).

***Course Learning Objectives: By completion of the course, the students should be able to:***

1. Perform safety calculations in support of the preparation of an abbreviated Safety Analysis Report for an advanced reactor.
2. Develop and quantify simplified fault and event trees for an advanced reactor.
3. Prepare a seismic analysis for a nuclear power reactor.
4. Prepare an abbreviated Safety Analysis Report for an advanced reactor.
5. Interpret the Nuclear Regulatory Commission’s requirements and policy statements for an advanced reactor system.
6. Make a formal presentation on the results of their analyses to a “mock” safety review board.
7. Demonstrate the strengths and weaknesses in an advanced reactor design.

| *NO* | *Topic Covered During Class:* | *Duration in Weeks* |
|---|---|---|
| 1 | Safety philosophies and safety criteria | **2** |
| 2 | Deterministic and probabilistic models, risk assessment | **2** |
| 3 | Reactor accidents | **2** |
| 4 | Engineering safety features | **2** |
| 5 | Release and dispersal of radioactive materials and radiological consequences | **2** |
| 6 | Calculation and assessment of doses following an accident | **3** |
| 7 | Reactor licensing | **2** |

***Class Schedule:***

- **Lecture**: Two 1.0 hour sessions per week
- **Tutorials**: Two 1.0 hours sessions per week

***Course Contribution to professional Component:***

- Engineering Science: 100 %
- Engineering Design: 0 %

***Course Relationship to Student Outcomes:*** **(f), (g), & (h)**

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Thermo Nuclear Fusion Technology** | **NE 424** | **هـ ن 424** | **3** | **-** | **-** | **3** |
| **Prerequisites** | | **NE 302, MEP 261** | | | | |
| Fusion requirements, fundamentals of plasmas at thermonuclear burning. Plasma confinement and heating, materials, reactor control, plant construction and maintenance. Dynamics, stability, and control. Fusion fuel production. Applications in tokamaks. Fusion-fission hybrid reactor, radiation sources in fusion plants and safety of nuclear fusion. | | | | | | |

Faculties and departments requiring this course (if any): none

***Textbook:*** V. A. Stefan, Laser Thermonuclear Fusion: Research Review. Stefan University Press; (2008).

***Reference:***Ma. Davoudi, Mo. Davoudi and G. Dantona, Diagnosis of Electron Cyclotron Heating Power Deposition on Plasma: For Controlling Thermonuclear Fusion Power in Tokamaks, VDM Verlag; (2010).

***Course Learning Objectives: By completion of the course, the students should be able to:***

1. Describe and distinguish different mechanisms of wall erosion and fuel retention.
2. Explain and assess the impact of physical and chemical processes on erosion of wall material.
3. Critically assess and motivate material choice for respective plasma-facing components.
4. Compare and assess fuel inventory in different wall materials and assess its impact on the fuel cycle.
5. Evaluate power loads to the wall during normal operation, disruptions and edge localised modes.
6. Relate thermo-mechanical properties of materials (CFC, W, Be) to their response to power loads
7. Relate wall erosion to its impact on plasma operation.
8. Explain causes for dust formation and assess the risk of such process for the reactor operation.
9. Select methods for studies (analysis) and qualification of wall materials.
10. Apply knowledge to experiment planning and conceptual design of: diagnostic for erosion-deposition measurement and propose the use of diagnostic for specific experiments in a controlled fusion device; plasma-facing components for testing under reactor conditions.

| *NO* | *Topic Covered During Class:* | *Duration in Weeks* |
|---|---|---|
| 1 | Fusion requirements, fundamentals of plasmas at thermonuclear burning | **2** |
| 2 | Plasma confinement and heating, materials, reactor control, plant construction and maintenance | **2** |
| 3 | Dynamics, stability, and control | **2** |
| 4 | Fusion fuel production | **2** |
| 5 | Applications in tokamaks | **2** |
| 6 | Fusion-fission hybrid reactor, | **2** |
| 7 | Radiation sources in fusion plants and safety of nuclear fusion. | **3** |

***Class Schedule:***

- **Lecture**: Two 1.0 hour sessions per week
- **Tutorials**: One 1.0 hours sessions per week

***Course Contribution to professional Component:***

- Engineering Science: 100 %
- Engineering Design: 0 %

***Course Relationship to Student outcomes:*** **(a), (g), & (k)**

<table>
<tr><th rowspan="2">Course Title</th><th rowspan="2">English Code /No</th><th rowspan="2">Arabic Code/No.</th><th colspan="4">Hours</th></tr>
<tr><th>Th.</th><th>Pr.</th><th>Tr.</th><th>Credit</th></tr>
<tr><td>Nuclear Reactor Design</td><td>NE 427</td><td>427هـ ن</td><td>3</td><td>-</td><td>-</td><td>3</td></tr>
<tr><td colspan="3">Prerequisites</td><td colspan="4">NE 411, NE 421</td></tr>
<tr><td colspan="7">Specifications of the principal parameters in reactor design (economic analysis to determine capital and operating costs, fuel management and fuel cycle optimization). Selection of fuel and cladding. Thermal Hydraulics design (convective and/or boiling heat transfer at fuel element surface, pressure drops, heat exchanger calculations, thermodynamic cycle efficiency, steam turbine reheat and regeneration, preheating and inlet sub-cooling). Use of computer codes to solve realistic design problems involving, criticality, fuel management, thermal hydraulics and shielding. Design and subsequent optimization of an entire system.</td></tr>
</table>

Faculties and departments requiring this course (if any): none

***Textbook:***D. G. Cacuci, Handbook of Nuclear Engineering: Vol. 2: Reactor Design. Springer; 1st edition, (2010).

***Reference:***A. Agung, Conceptual Design of a Fluidized Bed Nuclear Reactor: Statics, Dynamics and Safety-related Aspects.IOS Press; (2007).

***Course Learning Objectives: By completion of the course, the students should be able to*:**

1. Demonstrate competence in neutronic aspects of nuclear reactor design
2. Understand both qualitatively and quantitatively neutron transport in practical nuclear reactor systems
3. Solve the one-speed neutron diffusion equation for a variety of situations;
4. Analyze nuclear reactor fuel and core steady-state thermal performance;
5. Couple the reactor neutronics to the core thermal-hydraulics in a design environment.
6. Understand the nuclear power plant systems, licensing, design, operation & maintenance, safety, and security
7. Perform a general design and nuclear safety analysis for a simple reactor system

| *NO* | *Topic Covered During Class:* | *Duration in Weeks* |
|---|---|---|
| 1 | Atomic and Nuclear Physics | **2** |
| 2 | Reactor Heat Removal | **3** |
| 3 | Radiation Protection and Shielding | **2** |
| 4 | Nuclear Fuel Cycle | **2** |
| 5 | Neutron Diffusion and Moderation | **2** |
| 6 | Materials: selection of fuel and cladding, corrosion | **2** |
| 7 | Pressure Vessel: stress calculations, materials selection/thicknesses | **2** |
| 8 | Safety: temperature and void coefficients, emergency cooling, hazards considerations | **2** |
| 9 | Nuclear Power Plant Licensing | **2** |

***Class Schedule:***

- **Lecture**: Two 1.0 hour sessions per week
- **Tutorials**: Two 1.0 hours sessions per week

***Course Contribution to professional Component:***

- Engineering Science: 70 %
- Engineering Design: 30 %

***Course Relationship to Student outcomes:*** **(b), (c), & (f)**

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Nuclear Electronics II** | **NE 440** | **440 هـ ن** | **2** | **1** | **-** | **3** |
| **Prerequisites** | | **NE 341** | | | | |
| Conduction in solids. Semi-conductor devices, pulse amplifiers, pulse height discriminators, digital storage and counting circuits, timing circuits, multi-channel pulse height analysis. Data acquisition systems. | | | | | | |

Faculties and departments requiring this course (if any): none

***Textbook:*** V Polushkin, Nuclear Electronics: Superconducting Detectors and Processing Techniques. Wiley; 1st edition;(2004).

***Reference:*** S. Tavernier, Experimental Techniques in Nuclear and Particle Physics. Springer; 1st edition, (2010).

***Course Learning Objectives: By completion of the course, the students should be able to*:**

1. Demonstrate an understanding conduction in solids
2. Describe qualitatively and quantitatively the pulse amplifying process
3. Explain qualitatively and quantitatively the pulse height discriminators
4. Explain the characteristics and uses of nuclear detectors and calculate their properties (efficiency, energy resolution, time resolution, pulse-pair resolution, dead-time).
5. Be familiar with the multi-channel analyzer

| ***NO*** | ***Topic Covered During Class:*** | ***Duration in Weeks*** |
|---|---|---|
| 1 | Conduction in solids | **2** |
| 2 | Semi-conductor devices | **1** |
| 3 | Pulse amplifiers, pulse height discriminators | **2** |
| 4 | Digital storage and counting circuits | **2** |
| 5 | Timing circuits | **2** |
| 6 | Multi-channel pulse height analysis | **2** |
| 7 | Data acquisition systems. | **3** |

***Class Schedule:***

- **Lecture**: Two 1.0 hour sessions per week
- **Tutorials**: Two 1.0 hours sessions per week

***Course Contribution to professional Component:***

- Engineering Science: 70 %
- Engineering Design: 30 %

***Course Relationship to Student Outcomes:*** **(b), & (g)**

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Advanced Nuclear Radiation Measurements** | **NE 441** | **441 هـ ن** | **3** | **2** | **-** | **4** |
| **Prerequisites** | | **NE 340, NE 341** | | | | |
| Advanced radiation measuring equipment that includes: scintillation detectors, solid state detectors, neutron detectors and other types of detectors used for x-ray, gamma ray, neutron detection and spectrometry. Design of experiments; measurements of XRF, gamma rays and neutrons. | | | | | | |

Faculties and departments requiring this course (if any): None

***Textbook:*** G. F. Knoll, Radiation Detection and Measurements. John Wiley; 3rd edition (2000).

***Reference:*** N. Tsoulfanidis, Measurements and Detection of Radiation. Taylor & Francis; 3rd edition (2010).

***Course Learning Objectives: By completion of the course, the students should be able to:***

1. Describe properties of advanced x-ray and gamma detectors.
2. Describe methods of advanced x-ray and gamma detectors.
3. Describe properties of fast and slow neutron detectors.
4. Describe methods for fast and neutron measurements.
5. Describe properties of XRF detectors.
6. Measure different types of gamma rays.
7. Measure slow neutrons.
8. Measure fast neutrons.
9. Calibrate equipment for energy and efficiency.
10. Design new experiments for gamma, x-ray and neutron measurements.

| *NO* | *Topic Covered During Class:* | *Duration in Weeks* |
|---|---|---|
| 1 | Properties of advanced scintillation detectors | **2** |
| 2 | Gamma and x-ray detection and spectrometry by scintillation detectors | **2** |
| 3 | Properties of advanced solid state detectors | **2** |
| 4 | X-ray and gamma ray measurements and spectrometry by solid state detectors | **2** |
| 5 | Slow neutron interactions | **1** |
| 6 | Detectors and methods of slow neutron measurements | **2** |
| 7 | Fast neutron interactions | **1** |
| 8 | Detection and spectrometry of fast neutrons | **1** |
| 9 | New experiment | **1** |

***Class Schedule:***

- Lectures: Three 1.0 hour sessions per week.
- Labs.: Two 2.0 hours sessions per week or one 4.0 hours session per week

***Course Contribution to professional Component***:

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

***Course Relationship to Student Outcomes:*** **(a), (b), (c), & (g)**

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Technology of Radiation Equipment** | **NE 452** | **452 هـ ن** | **3** | **-** | **-** | **3** |
| **Prerequisites** | | **NE 340, NE 351** | | | | |
| Production and characteristics of x-rays, diagnostic radiology, quality of an image, special radiographic techniques in diagnostic radiography. High energy machines in medical applications: linear accelerators, cyclotrons, neutron generators and betatrons. | | | | | | |

Faculties and departments requiring this course (if any): None

***Textbook:*** W. Huda, Review of Radiologic Physics. Lippincott Williams & Wilkins; 1st edition (1995).

***Reference:*** J. T. Bushberg, J. Seibert, E. Leidholdt and J. Boone, The Essential Physics of
Medical Imaging. Lippincott Williams & Wilkins; 2nd edition (2001).

***Course Learning Objectives: By completion of the course, the students should be able to:***

1. Describe the production of X-rays
2. Identify the function of each component in X-ray machine.
3. Explain the characteristics of X-rays.
4. Explain the interactions of X-rays with matter
5. Demonstrate the formation of image on the photographic plate.
6. Define the quality of image.
7. Acquire the knowledge of CT imaging system.
8. Explain the image reconstruction in CT system.
9. Acquire the knowledge of MRI system.
10. Define the principle of Cyclotron Betatron.
11. Describe the principle of Linacs and Co-60 teletherapy machine
12. Acquire the knowledge of applications of these machines for radiation therapy

| ***NO*** | ***Topic Covered During Class:*** | ***Duration in Weeks*** |
|---|---|---|
| 1 | Production of X-rays | 1 |
| 2 | X-rays machine | 1 |
| 3 | Characteristics of X-ray | 1 |
| 4 | Production of Laser and ultrasound | 1 |
| 5 | Interaction of X-rays with matter/tissue | 1 |
| 6 | Image formation on photographic plate | 1 |
| 7 | Image quality | 1 |
| 8 | CT imaging system | 1 |
| 9 | Image reconstruction in CT system | 1 |
| 10 | Image formation in MRI system | 1 |
| 11 | Principle of cyclotron and Betatron for particle acceleration | 1 |
| 12 | Principle of Medical Linacs | 1 |
| 13 | Co-60 teletherapy machines | 1 |
| 14 | Radiation therapy using these machines | 1 |

***Class Schedule:***

- Lectures: Three 1.0 hour sessions per week.
- Tutorials: One 3.0 hours session per week.

***Course Contribution to professional Component***:

- Engineering science: 100%
- Engineering design: 0 %

***Course Relationship to Student Outcomes:*** **(e), (f), (g), & (i)**

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Rules and Regulation of Nuclear Radiation** | **NE 453** | **هـ ن 453** | **3** | **-** | **-** | **3** |
| **Prerequisites** | | **NE 451** | | | | |
| In this course the student will know rules and regulations of Nuclear radiation (local & international), recommendations of International Atomic Energy Agency (IAEA), International Commission of Radiation Protection (ICRP), and other international recommendations. He will also learn how to compare between those recommendations and their application in medical, industrial and environmental fields. | | | | | | |

Faculties and departments requiring this course (if any): None

***Textbook:*** International Atomic Energy Agency Publications, www.iaea.org.
***Reference:*** International Atomic Energy Agency Publications, www.iaea.org.

***Course Learning Objectives: By completion of the course, the students should be able to:***

1. Explain and discuss the general concept of the nuclear law
2. Define and describe the general concept of the regulatory body
3. Identify and describe the regional and international treaties, conventions, and agreements
4. Recognize and identify local rules and regulations of nuclear radiation
5. Recognize and identify recommendations of IAEA, ICRP, and other international bodies
6. Apply nuclear regulations in medical, industrial and environmental fields

| *NO* | *Topic Covered During Class:* | *Duration in Weeks* |
|---|---|---|
| 1 | Concepts of nuclear law (Risks and benefits and National legal hierarchy) | 1 |
| 2 | Definition of nuclear law | 1 |
| 3 | Objective of nuclear law | 1 |
| 4 | Principles of nuclear law | 1 |
| 5 | Legislative process for nuclear law | 3 |
| 6 | Security culture and safety culture in nuclear law | 1 |
| 7 | The Regulatory Body | 2 |
| 8 | Advisory bodies and external support | 1 |
| 9 | International Agreements Joined or Ratified by KSA | 1 |
| 10 | The State System of Accounting forand Control of Nuclear Materials (SSAC) | 2 |
| 11 | Local rules and regulations of nuclear radiation | 1 |
| 12 | Recommendations of IAEA, ICRP, and other international recommendations | 1 |
| 13 | Examples and Exemptions | 1 |
| 14 | Administrative requirements for radiation protection and safety of radiation sources | 1 |

***Class Schedule:***

- Lectures: Three 1.0 hour sessions per week.
- Tutorials: One 2.0 hours session per week.

***Course Contribution to professional Component***:

- Engineering science: 0 %
- Engineering design: 0 %
- Other 100%

***Course Relationship to Student Outcomes:*** **(f), (g), & (j)**

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Environmental Radioactivity** | **NE 454** | **454 هـ ن** | **3** | **-** | **-** | **3** |
| **Prerequisites** | | **NE 340, NE 351** | | | | |
| Natural radioactivity: radionuclides in the earth, cosmogeonic radioactivity, cosmic radiation, external and internal doses from natural radioactivity, sources of man-made radioactivity contamination covering fallout, radiation accidents, and radioactive waste. Pathways of radionuclides from environment to man. | | | | | | |

Faculties and departments requiring this course (if any): None

***Textbook:*** R. Tykva and J. Sabol, Low Level Environmental Radioactivity. Technomic Publication (1995).

***Reference:*** M. Eisenbud and T. Gesell, Environmental Radioactivity from Natural, Industrial & Military Sources. Academic Press; 4th edition (1997).

***Course Learning Objectives: By completion of the course, the students should be able to:***

1. Describe Terrestrial Radioactivity and list the three radioactive series that exist
2. Describe cosmogenic radionuclides and identify some of them
3. Explain cosmic radiation and its two components
4. Explain external and internal doses from natural radioactivity and means of determining the same
5. Describe radiation fall-out
6. Identify some of the nuclear accidents and assess the damages caused and their long- term effects
7. Explain radioactive waste and describe how to classify them. Explain different pathways of radionuclides reaching man
8. Identify different radionuclides that are transported through air, water and soil

| ***NO*** | ***Topic Covered During Class:*** | ***Duration in Weeks*** |
|---|---|---|
| 1 | Environmental Radioactivity – Introduction | **1** |
| 2 | Terrestrial and Cosmic Radiation | **1** |
| 3 | Contamination from Natural radioactivity (External) | **1** |
| 4 | Contamination from Natural radioactivity (Internal) | **1** |
| 5 | Sources of Man-made radioactivity | **1** |
| 6 | Radiation fall-out | **1** |
| 7 | Nuclear Accidents | **1** |
| 8 | Radioactive waste: Identification, classification | **1** |
| 9 | Radioactive waste disposal | **2** |
| 10 | Transport of radioactivity through air | **1** |
| 11 | Transport of radioactivity through water | **1** |
| 12 | Transport of radioactivity through Soil | **1** |
| 13 | Transport of radioactivity through Soil | **1** |

***Class Schedule:***

- Lectures: Three 1.0 hour sessions per week.
- Tutorials: Two 2.0 hours session per week.

***Course Contribution to professional Component***:

- Engineering science: 100 %
- Engineering design: 0 %

***Course Relationship to Student Outcomes:*** **(a), (e), (g), & (h)**

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Operational Radiation Protection** | **NE 456** | **456 هـ ن** | **3** | **-** | **-** | **3** |
| **Prerequisites** | | **NE 451** | | | | |
| Laboratory operation and good work practice, use of radiation survey meters, calibration, frequency of calibration. Radiation dose limits, limits of radionuclides in water in unrestricted areas, limits in sewerage, leakage and surface contamination limits, accessibility control, labeling, use of protection equipments, emergency procedures, low and intermediate waste management. | | | | | | |

Faculties and departments requiring this course (if any): None

***<u>Textbook:</u>*** H. Cember and T. Johnson, Introduction to Health Physics. McGraw-Hill Medical;4th edition (2008).

***<u>Reference:</u>*** Merril Eisenbud and Thomas Gesell, Environmental Radioactivity. Academic Press; 4th edition (1997).

***<u>Course Learning Objectives: By completion of the course, the students should be able to</u>*:**

1. Describe how measuring device operates (principally in terms of its energy and count rate response).
2. Recognize the diverse aspects of good work practice in labs (source storage, source containment, identification of radiation hazard, spillage, waste disposal).
3. Calibrate a measuring instrument.
4. Specify the radiation dose limits set by ICRP.
5. Apply the regulations related to release of radioactivity and waste disposal.
6. Describe different procedures to handle radiation incidents.

| ***NO*** | ***Topic Covered During Class:*** | ***Duration in Weeks*** |
|---|---|---|
| 1 | Laboratory operation and good work practice | **2** |
| 2 | Use of radiation survey meters | **2** |
| 3 | Calibration and frequency of calibration | **1** |
| 4 | Radiation dose limits | **1** |
| 5 | limits of radionuclides in water in unrestricted areas, limits in sewage | **2** |
| 6 | leakage and surface contamination limits | **2** |
| 7 | Accessibility control, labeling, use of protection equipments | **2** |
| 8 | Emergency procedures | **1** |
| 9 | Low and intermediate and high waste managements | **1** |

***Class Schedule:***

- Lectures: Three 1.0 hour sessions per week.
- Tutorials: Two 2.0 hours session per week.

***Course Contribution to professional Component***:

- Engineering science: 100 %
- Engineering design: 0 %

***Course Relationship to Student Outcomes:*** **(a), (d), (f), & (g)**

<table>
<tr><th rowspan="2">Course Title</th><th rowspan="2">English Code /No</th><th rowspan="2">Arabic Code/No.</th><th colspan="4">Hours</th></tr>
<tr><th>Th.</th><th>Pr.</th><th>Tr.</th><th>Credit</th></tr>
<tr><td>Low Level Radioactive Waste Management</td><td>NE 457</td><td>457 هـ ن</td><td>3</td><td>-</td><td>-</td><td>3</td></tr>
<tr><td colspan="3">Prerequisites</td><td colspan="4">NE 451</td></tr>
<tr><td colspan="7">Radioactive waste classification, Radiation toxicity of Radiation sources, Medical radioactive waste, industrial Radioactive waste. Sorting. Storage and transportation of radioactive waste. Radiation protection in treatment of radioactive waste.</td></tr>
</table>

***Textbook:*** J. H. Saling and A. W. Fentiman, Radioactive Waste Management. Taylor and Francis Editions; 2nd edition (2001).

***Reference:*** A. Rahman, Decommissioning and Radioactive Waste Management. Whittles Publishing; 1st edition (2008).

***Course Learning Objectives: By completion of the course, the students should be able to:***

1. Define roles and responsibilities of individuals as they pertain to the low level waste certification program
2. Show an understanding of the radioprotection associated with radioactive waste and decommissioning
3. Describe the proper disposal of protective clothing used in hospitals
4. Show ways to reduce the amount of low radioactive waste level
5. Recognize approved radioactive waste containers
6. Show an understanding of the various rules governing waste management.
7. Present methods to use to ensure radiation exposure is maintained As Low As Reasonably Achievable or ALARA.
8. Identify the requirements that must be met before a waste container can be picked up.
9. Identify situations/circumstances requiring emergency response.

| NO | *Topic Covered During Class:* | *Duration in Weeks* |
|---|---|---|
| 1 | Define roles and responsibilities of individuals as they pertain to the low level waste certification program | 2 |
| 2 | Show an understanding of the radioprotection associated with radioactive waste and decommissioning | 2 |
| 3 | Describe the proper disposal of protective clothing used in hospitals | 2 |
| 4 | Show ways to reduce the amount of low radioactive waste level | 2 |
| 5 | Recognize approved radioactive waste containers | 1 |
| 6 | Show an understanding of the various rules governing waste management | 2 |
| 7 | Present methods to use to ensure radiation exposure is maintained As Low As Reasonably Achievable or ALARA | 2 |
| 8 | Identify the requirements that must be met before a waste container can be picked up | 1 |
| 9 | Identify situations/circumstances requiring emergency response | 2 |

***Class Schedule:***

- Lectures: Two 1.0 hour sessions per week.
- Tutorials: One 1.0 hour session per week.

***Course Contribution to professional Component***:

- Engineering science: 30 %
- Engineering design: 0 %
- Other 70 %

***Course Relationship to Student Outcomes:*** **(f), & (i)**

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Radiation Emergency Planning** | **NE 458** | **458 هـ ن** | **2** | **2** | **-** | **3** |
| **Prerequisites** | | **NE 451** | | | | |

Plans and simulations of a real emergency case, spilling of open sources, losing radioactive sources, safety of sources during fire, spreading of radioactive sources, use and calibration of radiation protection related equipment. Visits to radiation facilities and reviewing their radiation protection rules and regulations and emergency plans. Calculation and assessment of doses following an accident, dealing with workers and public in emergency, reasonability of the workers in emergency, treating highly exposed people, emergency records.

Faculties and departments requiring this course (if any): none

***<u>Textbook:</u>***A. Ansari, Radiation Threats and Your Safety: A Guide to Preparation and Response for Professionals and Community.Chapman and Hall/CRC; 1st edition, (2009).

***<u>Reference:</u>*** Kenneth L. Miller Handbook of Management of Radiation Protection Programs. CRC Science; 2nd edition, (1992).

***<u>Course Learning Objectives: By completion of the course, the students should be able to:</u>***

1. Recognize the types of emergencies and disasters that can impact nuclear facilities
2. Understand the phases of emergency management
3. Classify emergency levels (unusual event, alert, site area emergency, general emergency)
4. Review the purpose of the Incident Command System
5. Describe key tasks to any evacuation
6. Apply the protective actions to minimize the public, livestock and farm exposures
7. Use and calibrate radiation protection related equipment
8. Calculate and assess of doses following an accident.

| NO | Topic Covered During Class: | Duration in Weeks |
|---|---|---|
| 1 | Types of emergencies and disasters that can impact nuclear facilities | **2** |
| 2 | Phases of emergency management | **1** |
| 3 | Emergency levels | **2** |
| 4 | key tasks to any evacuation | **1** |
| 5 | Protective actions to minimize the public, livestock and farm exposures | **2** |
| 6 | Calculation and assessment of doses following an accident | **3** |
| 7 | Use and calibration radiation protection related equipment | **2** |

***Class Schedule:***

- **Lecture**: Two 1.0 hour sessions per week
- **Tutorials**: Two 1.0 hours sessions per week

***Course Contribution to professional Component:***

- Engineering Science: 100 %
- Engineering Design: 0 %

***Course Relationship to Student outcomes:*** **(f) & (g)**

| Course Title | English Code /No | Arabic Code/No | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Radioisotopes Applications II** | **NE 460** | **460 هـ ن** | **3** | **-** | **-** | **3** |
| **Prerequisites** | | **NE 360** | | | | |
| Advanced applications of radioisotopes in medicine, agriculture and industry. Irradiation technology, radiography with neutrons, x-ray fluorescence. Sterilization of medical equipment, food irradiation, irradiation of polymers to improve their characteristics. | | | | | | |

Faculties and departments requiring this course (if any): None

***Textbook:*** J. R. Woods and A. K. Pikaev, Applied Radiation Chemistry: Radiation Processing. John Wiley & Sons; (1994).

***References:*** R. L. Murry, Nuclear Energy. Butterworth-Heinemann; (2001).
G. Foldiak, Industrial Applications of Radioisotopes. Elsevier; (1996).

***Course Learning Objectives: By completion of the course, the students should be able to:***

1. Understand different characteristics of radiation sources used in this course
2. Define polymerization, curing and grafting
3. Understand polymer modification by radiation
4. Discuss the use of different radiation sources for the production of beneficial changes in materials and the use of modified products in different fields
5. Discuss the treatment of foodstuffs by ionizing radiation
6. Discuss the radiation sterilization of medical products
7. Discuss the radiation treatment of different types of industrial and municipal wastes
8. Discuss the beneficial changes in agriculture products through mutation caused by radiation
9. Discuss “SIT” for control of insect and mosquito
10. Discuss X-ray fluorescence spectrometry and its use for measuring trace amounts of some materials
11. Differentiate between x-ray and neutron radiography
12. Discuss the use of different types of radionuclides for medical diagnosis and therapy

| *NO* | *Topic Covered During Class:* | *Duration in Weeks* |
|---|---|---|
| 1 | Irradiation technology, Radiography with neutrons, X-ray fluorescence | 2 |
| 2 | Irradiation of polymers to improve their characteristics | 2 |
| 3 | Food irradiation | 2 |
| 4 | Sterilization of medical products | 2 |
| 5 | Applications in agriculture | 2 |
| 6 | Medical applications | 2 |
| 7 | Applications of radioisotopes in hydrology | 1 |
| 8 | Other applications | 1 |

***Class Schedule:***
Lectures: Three 50 minutes sessions per week

***Course Contribution to professional Component***:
- Engineering science: 100 %
- Engineering design: 0 %
- Other 0 %

***Course Relationship to Student Outcomes:*** **(e), (f), & (g)**

<table>
<tr><td rowspan="2">Course Title</td><td rowspan="2">English Code /No</td><td rowspan="2">Arabic Code/No.</td><td colspan="4">Hours</td></tr>
<tr><td>Th.</td><td>Pr.</td><td>Tr.</td><td>Credit</td></tr>
<tr><td>Eddy Current Testing and Magnetic Particle Testing</td><td>NE 461</td><td>هـ ن461</td><td>3</td><td>1</td><td>-</td><td>3</td></tr>
<tr><td colspan="2">Prerequisites</td><td colspan="5">NE 361</td></tr>
<tr><td colspan="7">Importance of NDT, Manufacturing processes and typical defects, Electro-magnetic theory<br>EDDY CURRENT TESTING: Fundamental principles of Eddy current testing, Equipments and accessories, Applications and limitations, Minimum requirements for testing, Standards, Case studies<br>MAGNETIC PARTICLE TESTING: Fundamental principles of magnetic particle testing, Techniques, Equipments and accessories, Applications and limitations, Minimum requirements for testing, Standards, Case studies.</td></tr>
</table>

Faculties and departments requiring this course (if any): none

***Textbook:*** X. E. Gros, Applications of NDT Data Fusion. Springer; 1st edition (2001).

***Reference:*** P. E. Mix von John, Introduction to Non destructive Testing: A Training Guide. Wiley & Sons; (2005).

***Course Learning Objectives:*** By completion of the course, the students should be able to:

1. understand the electricity theory
2. test some industrial components by Eddy current method (pipe industry, aeronautic industry, etc)
3. know the advantages and the limits of eddy current technique
4. record the test results
5. take a decision: acceptance or rejection of the tested components by evaluating the results according to the related standards (ASME, EN, etc.)
6. understand the theory of magnetism
7. test some industrial components by magnetic particle method (welded, cast, heat treated, and forged samples)
8. know the advantages and the limits of this technique
9. record the test results
10. take a decision: acceptance or rejection of the tested components by evaluating the results according to the related standards (ASME, EN, etc.)

| ***NO*** | ***Topic Covered During Class:*** | ***Duration in Weeks*** |
|---|---|---|
| 1 | EDDY CURRENTS: Importance of NDT, Sciences of material, | **2** |
| 2 | manufacturing processes and defects | **1** |
| 3 | Fundamental principles, Eddy currents theory, | **2** |
| 4 | Equipments and testing procedures by Eddy currents, | **1** |
| 5 | The E.C testing applications, Limits of testing by Eddy currents, Minimum equipment recommended for practical. | **1** |
| 6 | Magnetic Particules: Materials, manufacturing and defects, | **1** |
| 7 | Physical principle, Method and technique of testing, | **1** |
| 8 | Equipments and accessories, Applications, Limit of the method, | **1** |
| 9 | Materials and equipment recommended for the practice. | **1** |

***Course Schedule:***

- Lecture: Three 1.0 hour sessions per week
- lab: one 3.0 hours session per week

***Course Contribution to professional Component:***

- Engineering science: 100%
- Engineering design: 0%

***Course Relationship to Student Outcomes:*** **(a), (b), (f), & (k)**

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Ultrasonic Testing And Liquid Penetrant Testing** | **NE 462** | **462 هـ ن** | **3** | **1** | **-** | **3** |
| **Prerequisites** | | **NE 361** | | | | |

**ULTRASONIC TESTING**: Importance of NDT, Fundamental principles, Theory of ultrasounds (physical principles), Ultrasonic field characteristics, Sound velocity, Attenuation of ultrasounds, Testing techniques, Equipments, Composition and functioning of an ultrasonic instrument, Equipments characteristics, Signal visualization, Calibration and operating methods, Controlling the properties of the transducers, Distance Amplitude Correction (DAC) method, Determining the location of defects, Defects sizing methods, Typical defects in the industrial components, Limits of using UT, Minimum equipment recommended, Standards and test instructions, Case studies (welding, casting, rolling).
**LIQUID PENETRANT TESTING**: Physical principles, Testing procedure, Accessories and testing equipments, Application fields and limits of the method, Practical and typical class of accessories, Calibration blocks, Case studies (welding, casting, forging).

Faculties and departments requiring this course (if any): none

***Textbook:*** X. E. Gros, Applications of NDT Data Fusion. Springer; 1st edition (2001).
***Reference:*** P. E. Mix von John, Introduction to Non destructive Testing: A Training Guide. Wiley & Sons; (2005).

***Course Learning Objectives:*** By completion of the course, the students should be able to:

Ultrasonic part of the course:

1. understand the interaction between the acoustical waves and the matter
2. calibrate the ultrasonic equipment, and then, to test some important industrial components such as welded, cast, forged, or rolled samples
3. know the advantages and the limits of ultrasonic technique
4. record the test results
5. take a decision: acceptance or rejection by evaluating the test results according to the related standards (ASME, EN, etc.)

Liquid penetrant part of the course:

6. test industrial components such as welded, cast, forged, or rolled samples by liquid penetrant method
7. know the advantages and the limits of liquid penetrant technique
8. record the test results
9. take a decision: acceptance or rejection of the tested components by evaluating the results according to the related standards (ASME, EN, etc.)

| *NO* | *Topic Covered During Class:* | *Duration in Weeks* |
|---|---|---|
| 1 | Importance of NDT, Fundamental principles | **1** |
| 2 | Theory of ultrasounds (physical principles), Ultrasonic field characteristics, | **2** |
| 3 | Attenuation of ultrasounds, Testing Techniques methods, | **1** |
| 4 | Equipments, calibration and operating methods, Composition and functioning of an ultrasonic instrument, Equipments characteristics, | **1** |
| 5 | Signal visualization, Equipments calibration, Transducers check, | **2** |
| 6 | Distance Amplitude Correction (DAC), | **1** |
| 7 | Defects location, Defects sizing methods, | **1** |
| 8 | Testing applications by UT, Limits of using UT, | **1** |
| 9 | Defects types, | **2** |
| 10 | Minimum equipment recommended, | **1** |
| 11 | Instructions and procedures | **1** |
| 12 | **LIQUID PENETRANTS** : Physical principles, Testing procedure, Testing procedure, Accessories and testing equipments | **1** |
| 13 | The application fields, Limits of the method, Practical and typical class of accessories, Calibration blocks. | **1** |

***Course Schedule:***

- Lecture: Three 1.0 hour sessions per week
- lab: one 3.0 hours session per week

***Course Contribution to professional Component:***

- Engineering science: 100%
- Engineering design: 0%

***Course Relationship to Student Outcomes:*** **(a), (b), & (h)**

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Industrial Radiography** | **NE 463** | **463هـ ن** | **3** | **1** | | **3** |
| **Prerequisites:** | | **NE 361** | | | | |
| Importance of NDT, Physical principles of radiation and radiography (X-rays, Gamma rays), Equipment, Films, Film development: manual, automatic , Film parameters , Filters and screens: principle and their influences, Image quality , Other accessories (markers, densitometer, illuminator), Exposure techniques: geometrical configurations, Exposure time, Interpretation and test report , Applications and limitations, Safety and radiation protection, Case studies from different industrial applications. | | | | | | |

Faculties and departments requiring this course (if any): none

***Textbook:*** X. E. Gros, Applications of NDT Data Fusion. Springer; 1st edition (2001).

***Reference:*** P. E. Mix von John, Introduction to Non destructive Testing: A Training Guide, Wiley & Sons; (2005).

***Course Learning Objectives: By completion of the course, the students should be able to*:**

1. understand the interaction between the electromagnetic waves and the matter
2. to test some important industrial components (welded and cast samples) by X and Gamma rays
3. know the advantages and the limits of this technique
4. record the test results
5. take a decision: acceptance or rejection by evaluating the radiographic films according to the related standards (ASME, ASTM, EN, etc.)

| ***NO*** | ***Topic Covered During Class:*** | ***Duration in Weeks*** |
|---|---|---|
| 1 | Importance of NDT, Physical principles of radiation and radiography (X-rays, Gamma rays), | **2** |
| 2 | Equipments (X-ray, Isotopes such as Ir192, Se75, Co60) | **2** |
| 3 | Films, Film development: manual, automatic , | **1** |
| 4 | Film parameters, Filters and screens: principle and their influences, Images quality, Other accessories (Markers, Densitometer, Illuminator), | **1** |
| 5 | Exposure techniques: geometrical configurations, | **2** |
| 6 | Exposure time, | **2** |
| 7 | Interpretation and testing report, | **1** |
| 8 | Applications, Limitations, | **1** |
| 9 | Safety and radiation protection (protection against radiation), | **2** |

***Course Schedule:***

- Lecture: Three 1.0 hour sessions per week
- lab: one 3.0 hours session per week

***Course Contribution to professional Component:***

- Engineering science: 100%
- Engineering design: 0%

***Course Relationship to Student Outcomes:*** **(a), (f), (g), & (k)**

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Radioanalytical Techniques** | **NE 464** | **هـ ن 464** | **3** | **-** | **-** | **3** |
| **Prerequisites** | | **NE 340** | | | | |
| Theory of Atomic Absorption Spectrometry (AAS) and its instrumentation. Principles of atomization and background correction, calibration procedures and their applications. Theory of X-ray Fluorescence (XRF) as an analytical tool. Qualitative and quantitative analyses, computer applications in quantitative spectral analysis and their applications. General principles of Neutron Activation Analysis (NAA). Treatment of experimental data, use of some available computer software. | | | | | | |

Faculties and departments requiring this course (if any): None

***Textbook:*** E. Berman, Toxic Metals and their Analysis. Heyden & Sons; (2006).

***References:*** S. J. Haswell, Atomic Absorption Spectrometry. Elsevier; (2001).
B. L. Carson and J. L. McCann, Toxicology and Biological Monitoring Of Metals in Humans. Lewis Publishers Inc.; (1999).

***Course Learning Objectives: By completion of the course, the students should be able to:***

1. Explain the theory of Atomic Absorption Spectrometry ( AAS)
2. Define and describe atomization, background correction and calibration of AAS
3. Discuss the applications of AAS for the measurement of trace elements in foodstuffs, biological samples
4. Discuss the theory of X-ray fluorescence ( XRF)
5. Apply the idea of XRF for the determination of trace elements
6. Explain the principle of Neutron Activation Analysis (NAA)
7. Apply the idea of NAA for the estimation of elemental concentrations in foodstuffs, biological samples etc.
8. Apply your idea of error calculation for the treatment of experimental data
9. Apply your computer skills for use of some available computer software.

| ***NO*** | ***Topic Covered During Class:*** | ***Duration in Weeks*** |
|---|---|---|
| 1 | Theory of Atomic Absorption Spectrometry( AAS) | 2 |
| 2 | Applications of AAS | 2 |
| 3 | Theory of X-ray Fluorescence ( XRF ) | 2 |
| 4 | Applications of XRF | 2 |
| 5 | Theory of Neutron Activation Analysis ( NAA) | 1 |
| 6 | Applications of NAA | 1 |
| 7 | Error calculations & analysis of experimental data | 2 |
| 8 | Applications of some available computer software | 2 |

***Class Schedule:***
Lectures: Three 45 min. sessions per week.

***Course Contribution to professional Component***:
- Engineering science: 100 %
- Engineering design: 0 %
- Other 0 %

***Course Relationship to Student Outcomes:*** **(a) & (i)**

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Radiochemistry** | **NE 467** | **467 هـ ن** | **3** | **-** | **-** | **3** |
| **Prerequisites** | | **NE 340, NE 351** | | | | |
| Theory and kinetics of radioactive decay, Chemical phenomenon in reactions and reactors, Chemical properties of radioactive elements, Chemical separation methods, Chemical aspect of nuclear energy, Isotope exchanges and radioactive tracer techniques in chemical applications, Preparation and use of some radiopharmaceuticals. | | | | | | |

Faculties and departments requiring this course (if any): None

***<u>Textbook:</u>*** G. Choppin, J. Rydberg and J-O Liljenzin. Radiochemistry and Nuclear Chemistry. Butterworth-Heinemann; 3rd edition (2001).

***<u>Reference:</u>*** W. D. Ehmann and D. E. Vance, Radiochemistry and Nuclear Methods of Analysis (Chemical Analysis: A Series of Monographs on Analytical Chemistry and its Applications). Wiley-Interscience; (1993).

***<u>Course Learning Objectives: By completion of the course, the students should be able to:</u>***

1. Show an understanding of the theory and kinetics of radioactive decay
2. Show an understanding of the theory and phenomena of nuclear reactions
3. Show an understanding of the nature and energetics of radioactivity,
4. Show an understanding of the chemical properties of radioactive elements
5. Show an understanding of the use of radioactive elements in the study of some biological and physical phenomena
6. Show an understanding of the radioactive tracer techniques in chemical applications
7. Know how Radiopharmaceuticals are used in routine use B001HPMWTE

| ***NO*** | ***Topic Covered During Class:*** | ***Duration in Weeks*** |
|---|---|---|
| 1 | Theory and kinetics of radioactive decay | 2 |
| 2 | Chemical phenomenon in reactions and reactors | 2 |
| 3 | Chemical properties of radioactive elements | 2 |
| 4 | Chemical separation methods | 2 |
| 5 | Isotope exchanges | 2 |
| 6 | radioactive tracer techniques in chemical applications | 2 |
| 7 | Preparation and use of some radiopharmaceuticals | 2 |

***Class Schedule:***

- Lectures: Two 1.0 hour sessions per week.
- Tutorials: One 1.0 hour session per week.

***Course Contribution to professional Component:***

- Engineering science: 20 %
- Engineering design: 0 %
- Other 80 %

***Course Relationship to Student Outcomes:*** **(a) & (b)**

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| Radiotherapy II | NE 475 | 474هـن | 3 | 0 | 3 | 3 |
| Prerequisites | | NE 470 | | | | |
| Tumor treatment with high energy X-ray and with high energy electron beam from linear accelerators, and with neutron therapy through neutron capture, ionizing radiation treatment of tumor by means of directed beam, treatment by radioactive sealed and unsealed sources, measurement of dose, treatment planning. | | | | | | |

Faculties and departments requiring this course (if any): None

***Textbook*:** F. M. Khan,The Physics of Radiotherapy. Lippncott Williams & Wilkens. 3rd edition; (2003)

***References:***W. R. Hendee, G. S. Ibbott, and I. G. Hendee, Radiation Therapy Physics.Wiley-Liss; 3rd edition (2004)

E.B. Podgorzak, Radiation Oncology Physics A Handbook for Teachers and Students. IAEA; (2005).

***Course Learning Objectives: By completion of the course, the students should be able to*:**

1. Describe a external beam radiation therapy system and break down into its main components, for each of the radiation therapy machines covered (Co-60, Linac, and Linac)
2. Describe a interall beam radiation therapy system and break down into its main components, for each of the radiation therapy machines covered (Breakytherapy)
3. Understand and Describe Radiation Treatment Plannning
4. Remember the terms associated with Radiotherapy
5. Remember the dose calculation parameters
6. Define and explain the key factors that affect radiotherapy treatment
7. Understand published scientific articles that relate to radiotherapy and be able to communicate their understanding in a professional manner.
8. Learn to communicate the physical principles behind radiotherapy technology and relevant applications
9. Practice and apply elements of active learning, develop team norms and writing skills.
10. Able to critically evaluate bodies of literature in radiotherapy applications
11. Integrate ideas from physics and engineering into medicine
12. See themselves as students who are much more educated about the physics of radiotherapy
13. Able to inform and educate others about the role of radiotherapy in personal and public life
14. Be excited about the physics of radiotherapy as a broad, complex, multifaceted field of study
15. Value the importance of precise language used in the field of radiotherapy as part of professionalism
16. Be able how to read assigned materials responsibly.

| *NO* | *Topic Covered During Class:* | *Duration in Weeks* |
|---|---|---|
| 1 | **Classical radiation therapy**<br>• Dose Distribution and scatter analysis | **1** |
| 2 | • A system of dosimetric calculations<br>• Treatment Planning I: Isodose distributions | **1** |
| 3 | • Treatment Planning II: Patient Data corrections and setup<br>• Treatment Planning III: Field shaping , skin dose, and field separation | **2** |
| 4 | • Electron Beam Therapy | **1** |
| 5 | • Brachytherapy | **1** |
| 6 | • Radiation Projection<br>• Quality Assurance<br>• Total Body Irradiation | **1** |
| 7 | **Modern Radiation Therapy**<br>Three-dimentional conformal radiation therapy | **1** |
| 8 | • Intensity-modulated radiation therapy | **1** |
| 9 | • Stereotactic Radiosurgery | **1** |
| 10 | • High dose Rate Brachytherapy | **1** |
| 11 | • Protstate Implants | **1** |
| 12 | • Intravascular Brachytherapy | **1** |
| 13 | • Intravascular Brachytherapy | **1** |

***Class Schedule:***

- Lecture: three one hour session per week
- Tutorials: three hours session per week

***Course Contribution to professional Component:***

- Engineering science: 100%
- Engineering design:  0%

***Course Relationship to Student Outcomes:*** **(a), (g), & (k)**

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Advanced Medical Imaging** | **NE 477** | **477 هـ ن** | **3** | **-** | **-** | **3** |
| **Prerequisites** | | **NE 474** | | | | |
| Image processing, image enhancement, linear and nonlinear filters, segmentation techniques, rigid and affine registration techniques, 3D visualization techniques: surface and volume rendering, morphometric quantitative measurements from medical image data; surface area, volume, and shape index. image processing algorithms, programs in Matlab that implement signal processing methods and estimators used in medical imaging. | | | | | | |

Faculties and departments requiring this course (if any): None

***<u>Textbook:</u>*** J.E. Bushberg, J.A. Seibert, E.M. Leidholdt JR, and J.M. Boone, The Essential Physics of Medical Imaging. Lippncott Williams & Wilkens Editions; 2$^{nd}$ edition (2002).

***<u>Reference:</u>*** P. Suetens, Fundamentals of Medical Imaging. Cambridge University Press; (2002).

***<u>Course Learning Objectives: By completion of the course, the students should be able to</u>*:**

1. Explain the signal processing involved in making a B-mode ultrasound image.
2. Explain signal processing methods for estimating blood velocity using ultrasound.
3. Explain back-projection algorithms used in CT, MR, and PET scanners.
4. Write programs in Matlab that implement signal processing methods and estimators used in medical imaging.
5. Give a quantitative evaluation of signal and image processing algorithms in terms of performance and accuracy.
6. Write a scientific report explaining a signal processing algorithm implementation made in Matlab and quantifying its performance.

| ***NO*** | ***Topic Covered During Class:*** | ***Duration in Weeks*** |
|---|---|---|
| 1 | Image processing, image enhancement | **2** |
| 2 | linear and nonlinear filters | **1** |
| 3 | segmentation techniques | **1** |
| 4 | rigid and affine registration techniques | **1** |
| 5 | x-ray machine radiation measurements | **1** |
| 6 | 3D visualization techniques | **3** |
| 7 | Write programs in Matlab that implement signal processing methods and estimators used in medical imaging. | **3** |

***Class Schedule**:*

- **Lecture**: Two 1.0 hour sessions per week
- **Tutorials**: One 1.0 hours sessions per week

***Course Contribution to professional Component**:*

- Engineering Science: 70 %
- Engineering Design: 30 %

***Course Relationship to Student Outcomes:*** **(a), (b), (e), & (k)**

<table>
<tr><th rowspan="2">Course Title</th><th rowspan="2">English Code /No</th><th rowspan="2">Arabic Code/No.</th><th colspan="4">Hours</th></tr>
<tr><th>Th.</th><th>Pr.</th><th>Tr.</th><th>Credit</th></tr>
<tr><td>Quality Assurance Of Medical Equipments</td><td>NE 478</td><td>478 هـ ن</td><td>3</td><td>-</td><td>-</td><td>3</td></tr>
<tr><td colspan="2">Prerequisites</td><td colspan="5">NE 340, NE370, NE 451</td></tr>
<tr><td colspan="7">Quality assurance of radiation protection in medical centers. Quality control and testing techniques for all types of diagnostic x-ray machine and nuclear medicine imaging equipment.</td></tr>
</table>

Faculties and departments requiring this course (if any): None

***Textbook:*** C. J. Martin and D. G. Sutton, Practical Radiation Protection in Healthcare.Oxford University Press; (2002).

***Reference:***S. C. Bushong, Radiation Science for Technologists. Elsevier-Mosby; (2008).

***Course Learning Objectives: By completion of the course, the students should be able to:***

1. Describe general and mobile x-ray machines and parameters.
2. Describe Mammography and Fluoroscopy machines and parameters.
3. Describe CT Machines and parameters.
4. Define resolution, contrast, surface dose, HVL. Focal spot size.
5. Define accuracy, consistency, reproducibility in QC measurements
6. Describe equipment used for QC of diagnosis x ray equipments
7. Measure accuracy, consistency, reproducibility in QC of x-ray machines
8. Measure Entrance Surface Dose and Dose-Area Products
9. Calculate errors in QC measurements.
10. Measure leakage radiation, scattered radiation and primary radiation
11. Describe radiation safety aspects in medical centers

| NO | Topic Covered During Class: | Duration in Weeks |
|---|---|---|
| 1 | General properties of x-ray machines | **2** |
| 2 | Mammography and Fluoroscopy machines and parameters | **1** |
| 3 | CT Machines and parameters | **1** |
| 4 | Quality control parameters in diagnostic x-ray machines | **3** |
| 5 | x-ray machine radiation measurements | **1** |
| 6 | Workers and patient safety aspects in diagnostic x-ray machines rooms | **2** |
| 7 | Patient dose measurements | **1** |
| 8 | Equipment check | **1** |
| 9 | Nuclear medicineQC | **2** |

***Class Schedule**:*

- **Lecture**: Two 1.0 hour sessions per week
- **Tutorials**: Three 2.0 hours sessions per week

***Course Contribution to professional Component**:*

- Engineering Science: 90 %
- Engineering Design: 10 %

***Course Relationship to Student Outcomes:*** **(b), (c), (f), & (k)**

| Course Title | English Code /No | Arabic Code/No. | Hours | | | |
|---|---|---|---|---|---|---|
| | | | Th. | Pr. | Tr. | Credit |
| **Brachytherapy** | **NE 479** | **479 هـ ن** | **2** | **2** | **-** | **3** |
| **Prerequisites** | | **NE 470** | | | | |

Physics and dose calculation, introduction to radiobiology, use of radiation sources in radiotherapy, preparation of sources and their applications, brachytherapy planning technique: reconstruction, points and axes, positioning, normalization, prescription, optimization techniques including geometric, volumetric and inverse, plan evaluation and outputs, principles of treatment: LDR, HDR, PDR cervix, UTM; prostate HDR, permanent seeds; breast; X- ray, CT, MRI imaging and target definition.

Faculties and departments requiring this course (if any): none

***Textbook:*** F. M. Khan, The Physics of Radiation Therapy, Williams & Wilkins (2009).

***Reference:*** G. Bentel, Radiation Therapy Planning. McGraw-Hill Professional; 2nd edition (1995).

***Course Learning Objectives: By completion of the course, the students should be able to:***

1. Describe the how to calculate dose to certain oragans (i.e. prostate)
2. Describe the radiobiology concept due Brachytherapy & Radiotherapy
3. Describe the different radioisotopes used in Brachythrapy
4. Describe the principles of treatments and the optimization techniques.