

**MULTIMEDIA UNIVERSITY OF KENYA** P.O. Box 15653 - 00503, Mbagathi, Nairobi Tel: +254 020 2071391, +254 020 724257083, +254 020 735900008 Fax: +254 020 2071243 Email:**info@mmu.ac.ke**

***Leader in Innovative Technology***

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**FACULTY OF SCIENCE & TECHNOLOGY**

**DEPARTMENT OF PHYSICS**

**COURSE OUTLINE**

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| --- | --- |
| **Unit Code & Title**  | SPE 2425 NUCLEAR ENERGY TECHNOLOGY |
| **Prerequisite** | SPE 2415 NUCLEAR PHYSICS |
| **Class/Group** | Bachelor of science in Renewable Energy and Technology: Year 4 semester 2 |
| **Lecturer** | Mr. Nzuki |
| **Contact** | Email: nzukinzukia2.@gmail.com; Phone: 0722772625 |

**Purpose:**

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To equip the student with knowledge and skills necessary in Nuclear Energy harnessing and the required safety precautions

**Learning Outcomes:**

At the end of this course, the student should be able to:

1. Explain the global status in the exploitation of nuclear energy
2. Describe various nuclear energy technologies
3. Discuss ways of enhancing nuclear reactor safety

**Course Description**

History of Nuclear Energy: Rise of nuclear Physics, development of nuclear weapons, International atomic energy agency; Biological effects of radiation: Physiological effects, radiation dose effects, basis for limits of exposure, sources of radiation dosage; Radiation protection: Protective measures, calculation of dose, effect of distance and shielding, radionuclides in the environment, the radon problem, environmental radiological assessment; Information from isotopes: Stable and radioactive isotopes, tracer techniques, radiopharmaceuticals, medical imaging, radiometric dating, radiation gauges; Useful radiation effects: Medical treatment, radiation preservation of food, sterilization of medical supplies, pathogen reduction, insect control; Isotope separators: Mass spectrograph, gaseous diffusion separator, gas centrifuge, uranium enrichment, Laser isotope separation; Neutron chain reactions: Criticality and multiplication, fast and thermal reactor criticality, four factor formula parameters: Nuclear heat energy: Fuel element conduction and convection, temperature distribution through a reactor, steam generation and electrical power production; Nuclear power plants: Reactor types, power reactors, light water reactors, generation II, III & IV reactors; Reactor safety and security: Nuclear regulatory commission, emergency core cooling and containment, probabilistic risk assessment, three mile island accident, Chernobyl accident, Fukushima Daiichi accident, nuclear security; Radioactive waste disposal: nuclear fuel cycle, waste classification, spent fuel storage, transportation and reprocessing, future of nuclear energy

**Teaching methodology:**

### Lectures, laboratory practical’s, class discussions, tutorials, and field excursions

### Instruction materials/equipment:

1. Liquid Crystal Displays.

2. Laptop

3. Laboratory equipments and components

4. White boards and white board makers

5. Flip charts

# Course Content

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| **WEEK** | **TOPIC** | **OUTLINE** |
| 1 & 2 | * Course registration
* Discussing course outline
* History of Nuclear Energy
 | * Rise of nuclear Physics
* Development of nuclear weapons
* International atomic energy agency
 |
| 3 &4 | * Biological effects of radiation
 | * Physiological effects
* radiation dose effects
* basis for limits of exposure
* sources of radiation dosage
 |
| 5, & 6 | * Radiation protection
 | * Protective measures
* calculation of dose
* effect of distance and shielding
* radionuclides in the environment
* the radon problem
* environmental radiological assessment
 |
| 7 & 8 | * Information from isotopes
 | * Stable and radioactive isotopes
* tracer techniques
* radiopharmaceuticals
* medical imaging
* radiometric dating
* radiation gauges
 |
| 9 | * C. A. T. 1
* Presentations
 | C. A. T. 1 |
| 10  | * Useful radiation effects
* Isotope separators:
 | * Medical treatment
* radiation preservation of food
* sterilization of medical supplies
* pathogen reduction
* insect control
* Mass spectrograph
* gaseous diffusion separator
* gas centrifuge
* uranium enrichment
* Laser isotope separation
 |
| 11 & 12 | * Neutron chain reactions
* Nuclear heat energy
 | * Criticality and multiplication
* fast and thermal reactor criticality
* four factor formula parameters
* Fuel element conduction and convection temperature distribution through a reactor
* steam generation and electrical power production
 |
|  13  | * Nuclear power plants:
* Reactor safety and security:
 | * Reactor types
* power reactors
* light water reactors
* generation II, III & IV reactors
* Nuclear regulatory commission
* emergency core cooling and containment
* probabilistic risk assessment
* three mile island accident
* Chernobyl accident
* Fukushima Daiichi accident
* nuclear security
 |
| 14 | * Radioactive waste disposal
 | * nuclear fuel cycle
* waste classification
* spent fuel storage
* transportation and reprocessing
* future of nuclear energy
 |
| 15 & 16 | UNIVERSITY EXAMINATIONS |

### Course Assessment:

Continuous Assessment 30%

End of Semester Examination 70%

### Core Reading Materials:

1. Takigawa N., and Washiyama K. (2017). *Fundamentals of Nuclear Physics, (1st Ed.).* Springer, ISBN-13: 978-4-431-55377-9
2. Murray R., and Holbert K.E. (2014). *Nuclear Energy: An Introduction to the Concepts, Systems, and Applications of Nuclear Processes, (7th Ed.).* Butterworth-Heinemann, ISBN-13: 978-0124166547
3. Joyce M. (2017). *Nuclear Engineering: A Conceptual Introduction to Nuclear Power, (1st Ed.).* Butterworth-Heinemann, ISBN-13: 978-0081009628

**Course Journals**

1. [*Journal of Physics B: Atomic, Molecular and Optical Physics, ISSN: 0953-4075*](http://iopscience.iop.org/0953-4075/)
2. [*Journal of Physics G: Nuclear and Particle Physics, ISSN: 0305-4616*](http://iopscience.iop.org/0954-3899/)
3. *Journal of Applied Physics, ISSN: 0021-8979*

**Reference Materials:**

**Reference Textbooks**

1. Lamarsh J.R., and Baratta A.J. (2017). *Introduction to Nuclear Engineering (4th Ed.)* Pearson, ISBN-13: 978-0134570051
2. Shultis J.K., and Faw R.E. (2016). *Fundamentals of Nuclear Science and Engineering, (3rd Ed.).* CRC Press, ISBN-13: 978-1498769297
3. Murty K.L., and Charit I. (2013). *An Introduction to Nuclear Materials: Fundamentals and Applications, (1st Ed.).* Wiley, ISBN-13: 978-3527407675

**Reference Journals**

1. [*Review of Physics in Technology, ISSN: 0034-6683*](http://iopscience.iop.org/0034-6683/)
2. *APL: Organic Electronics and Photonics, ISSN:1941-420X*

#### Journal of Modern Optics, ISSN: 0950-0340

Approved by: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_