Department of Physics

College of Science

University of Salahaddin

Nuclear Physics

Course Book – (3rd Year communication Physics/2nd Semester)

Lecturer's name **M.Sc. Rozhan Dilshad Haider**

Academic Year: 2023-2024

Course Book

1. Course name	Nuclear Physics
2. Lecturer in charge	M.Sc. Rozhan Dilshad Haider
3. Department/ College	College of Science, Physics Department
4. Contact	E-mail: rozhan.haider@su.edu.krd
5. Time (in hours) per week	Theory 2.0 (Two only)
6. Office hours	At least 12 h/week
7. Course code	
8. Teacher's academic profile	I received my B.Sc. degree in physics from Salahaddin University, Erbil, Iraq, in 2006. In the 2007, I got a position in Salahaddin University, Erbil, Kurdistan, as a laboratory demonstrator. I stayed with this job for two years before study master's degree. Then, I have received M.Sc. degree in the nuclear physics from, Salahaddin University, Erbil Iraq, in 2013. I worked at the Salahaddin university as a University Assit.Lecturer until know.
9. Keywords	

10. Course overview:

This course will throughout one course in the year. During that the students will study many physical aspects of nuclear physics. In this one course students will also study Basic nuclear property, nuclear binding energy, Liquid-Drop-Model, Shell Model, The collective nuclear model, The optical nuclear model, Interaction of charged particles with matter, (photoelectric effect, Compton effect, pair production effect), Attenuation of gamma ray, Radioactivity, Gamma decay, Alpha decay, Beta decay, Nuclear reactions, Nuclear reaction in center of mass system, nuclear fission, Nuclear fusion, Detectors.

11. Course objective:

During this course in Nuclear Physics. We will begin with Basic nuclear property (nuclear mass and charge, nucleus, protons, neutrons, Rutherfords experiment, discovery of neutron, size, shape and density of nucleus), Classification of elements(nuclides, atomic no.,isotopes, isobars, isotons, isomers)., as an introduction to basic nuclear property. We continue with nuclear binding energy, Liquid-Drop-Model, Shell Model. The collective nuclear model, The optical nuclear model, Interaction of charged particles with matter, (photoelectric effect, Compton effect, pair production effect), Attenuation of

gamma ray, Radioactivity, Gamma decay, Alpha decay, Beta decay, Nuclear reactions, Nuclear reaction in centre of mass system, nuclear fission, Nuclear fusion, Detectors.

12. Student's obligation

Students should attend all the lectures and they may take notes during the lectures. In addition, in class participation would be advantage for them to extend their knowledge and understand the module systematically.

Attending the lectures regularly would be a crucial point for the students to consider. If the students missed few lectures, they would have difficulty to get back on the track.

Furthermore, all exams and tests done with books closed, and, students have to take at least two compulsory exams with few class test and quizzes during the years of study.

13. Forms of teaching

During this course, I am using some ways to make the students engage with the lecture like power point slides explanation view, white bard in the class and videos and animations to explain the theory of the subject with the explanation in the class. If there were slides that needed more explanation, or, if the slide needed a long, explanation and I thought that the students must know all of that, I would distribute the printed out version of the description on the students to widen their knowledge on the subject.

14.Assessment scheme

Two or Three examinations	30 %
For each chapter one Quiz and Homework	10%
Final examination	60%

15. Student learning outcome:

Students who took this course of Nuclear Physics would be able to understand Basic nuclear property, nuclear binding energy, Liquid-Drop-Model, Shell Model, The collective nuclear model, The optical nuclear model, Interaction of charged particles with matter , (photoelectric effect, Compton effect, pair production effect), Attenuation of gamma ray, Radioactivity , Gamma decay , Alpha decay , Beta decay , Nuclear reactions , Nuclear reaction in center of mass system , nuclear fission, Nuclear fusion , Detectors .

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16. Course Reading List and References:

[1] W.E. Meyerhof, Elements of Nuclear Physics, McGraw-Hill, Inc. USA, 1967.

[2] DOE-HDBK-1019/1-93(Nuclear physics and reactor theory),U.S.Department of energy (1993).

[3] Nicholas Tsoulfanidis (Measurement and detection of radiation), Taylor and francis com. (1995).

[4] J.K. Shultis and R.E. Faw, (Fundamental of nuclear science and engineering), Marcel Dekker,USA, (2002)

[5] K.S. Krane, (Introductory Nuclear Physics), John Willey & Sons, Inc., Singapore and Canada 1988.

[6] Ronald G. and William S., (Theory and Problems of Modern Physics), McGraw-Hill, Inc. USA,2002.

[7] Jean L., James R., Michel S., (Fundamentals in Nuclear Physics), Springer Science +Business Media, USA,2004.

17. The Topics:	**Lecturer's name**
Week (1):: Basic nuclear property (nuclear mass and charge, nucleus, protons,neutrons,quarksRutherfords experiment, discovery of neutron, size, shape and density of nucleus), Classification of elements(nuclides,atomic no.,isotopes,isobars,isotons,isomers). **Week (2):.** Atomic mass unit, nuclear binding energy, separation energy of neutrons, separation energy of protons, separation energy of alpha particles, nuclear force ,gravitational force, coulomb force. **Week (3):** Liquid-Drop-Model (Semi empirical mass formula). **Week (4):** Shell Model, Spin-Orbit coupling model, Rules of angular momentum and parities	M.Sc. Rozhan Dilshad Haider

For ground states of nuclei.

Week (5):

The collective nuclear model, The optical nuclear model

Week (6):

Interaction of charged particles with matter, Mechanisms of charged particle energy loss, stopping power, stopping power due to ionization and excitation

Week (7):

Interaction of gamma radiation with matter(photoelectric effect, Compton effect, pair production effect)

Week (8):

Attenuation of gamma ray, Radioactivity

Week (9):

Gamma decay, Energetics of gamma decay , Internal conversion, Parity, Classification of gamma decays

Week (10):

Alpha decay, Energetic of alpha decay, Decay constant of alpha decay, Alpha particle spectra

Week (11):

Beta decay(β^- dcay, β^+ decay) , Electron Capture decay

Week (12):

Nuclear reactions, Nuclear k (15):n lab. System, Conservation of energy, conservation of momentum,

Week (13):

Nuclear reaction in center of mass system, Types of nuclear reaction, Threshold energy of nuclear reaction, Cross sections.

Week (14):

nuclear fission, Nuclear fusion

Week (15):

Detectors(Gas filled detectors, Scintillation detectors, Semiconductor detectors)

19. Examinations:

A sample:

University of Salahaddin **First Examination in Nuclear** **Time: 1.5 hours**
Department Physics **Physics for B.SC Students** **Date: / /**
College of Science

[Q.1] (a) Define the following atomic terms?.
1-Isotopes 2- Isotones 3- Isobars 4-Isomers
(b)/Choose the isotopes, isotones and isobars from the following?.
$^{123}_{53}I$, $^{131}_{50}Sn$, $^{125}_{48}Cd$, $^{124}_{53}I$, $^{131}_{51}Sb$, $^{126}_{49}In$, $^{125}_{53}I$, $^{131}_{52}Te$, $^{127}_{50}Sn$

[Q.2] Determine the atomic mass and the mass excess of ($^{27}_{13}Al$) .?. If you know that the mass of proton (M_P= 1.007825 a.m.u) and the mass of neutron (M_n= 1.008665 a.m.u)

[Q.3] One of the reactions which occurs when beryllium is bombard with (1.75 MeV) alpha particles is { $^{9}_{4}Be(\alpha,n)^{12}_{6}C$] . The neutrons coming off at an angle of (90^0) with the direction of the alpha particle beam.
What is the kinetic energy of the neutrons ?.

[Q.4] If (P) and (D) are the parent and daughter nuclides respectively. Write the four general B^+ decay and electron capture decay?. nuclear equations of (Alpha decay, B^- decay,

[Q.5] Write the electron distribution of the element [$^{45}_{21}Sc$] in the atomic shells by using (s,p,d,f) rules and determine the number of (electrons), (protons), and (neutons) with the schematic of the atom ?.

Constants:

M(α)=4.00260325 amu ; M(n)=1.008665 amu ; M(C-12)= 12 amu

********** Good Luck ********