PHYSICS 722/822 - Fall Semester 2018 - ODU

Syllabus - Graduate Nuclear and Particle Physics I

Website: http://ww2.odu.edu/~skuhn/NucPhys/teaching.html
Class Meetings: 1:30 p.m. - 2:45 p.m. -- Tuesdays and Thursdays
Oceanography & Physics (OCNPS) Building Room 202

Instructor: Dr. Sebastian E. Kuhn
Eminent Scholar & Professor of Physics
Physical Sciences Building (PSB II), Room 2100J
Phone: 683 – 5804 email: skuhn at odu.edu
Web: http://www.odu.edu/~skuhn/

Office hours: Fridays 11:00 – 12:00 in my office
and by appointment (just ask me after class, send email or call)

Required Textbook:	Povh/Rith/Scholz/Zetsche/Rodejohann: Particles and Nuclei, Springer Verlag, 7th edition (2015). (Softcover, ebook, or older editions are fine).
Optional Textbooks:	Samuel S.W. Wong: Introductory Nuclear Physics, Wiley-VCH, 2nd edition (2004)
	Donelly/Formaggio/Holstein/Milner/Surrow: Foundations of Nuclear and Particle Physics, Cambridge University Press(2017)
Further Material:	Particle Data Group website (pdg.lbl.gov) and publications (pocketbook, full edition)
	A. Aprahamian et al.: Reaching for the Horizon – The 2015 Long Range Plan for Nuclear Science (2015) – on the web (google it)
	W.R. Leo: Techniques for Nuclear and Particle Physics Experiments, Springer (1994). (**The** standard text on experimental methods).

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INTRODUCTION

From the Catalog:

PHYS 722. Nuclear and Particle Physics I. 3 Credits.
Nuclear forces, models of nuclear structure and reactions, hadron and lepton scattering, introduction to constituent quark model and hadron spectroscopy. Prerequisites: PHYS 621.

This is the first semester of a 2-semester sequence in graduate nuclear and particle physics. The goal of the first semester will be to provide an overview of the main approaches and results of subatomic physics in a unified framework. The course will be relatively light on theory (trying to convey the main insights and ideas underlying today's Standard Model) but will require some grounding in Quantum Mechanics (many-body wave functions, angular momentum and spin, scattering, and perturbation theory) as well as electromagnetism. The main emphasis will be on the experimental methods and results and their interpretation. While the course is intended to provide a foundation for students planning (or doing) research in particle or nuclear physics, it should also be of interest to students working in accelerator science and atomic physics, as part of their "general education".

I will follow the required textbook as a guideline but will cover some topics in substantially more depth (while skipping others). In particular, "Nuclear Physics" proper (i.e. dealing with $A >> 1$) will be left to the 2nd semester (as will specific examples of forefront research in various areas of nuclear and hadronic physics). If you have access to the other listed books, they can be useful as additional background material. In particular, I will borrow some material from the book by Donelly et al.

Required course work includes attendance at the lectures, solving homework problem sets (approximately 1 each week), one midterm and one comprehensive final exam (both take-home). In addition, all students must contribute a "participation project" in form of a lecture note, a short presentation on applications of nuclear physics, or a report on a publication related to our course. Please pick a topic/format early in the semester, after consultation with me.

Grading Scheme:

Approximately 40% based on homework problem sets, 15% on participation, 15% on midterm, and 30% on the final exam.

Policy on Classroom Etiquette

Please follow the general rules of courtesy and respect. This means: Do **not** come late or leave early, and while in class, refrain from all other activities (including eating and drinking, talking to others, using electronic devices etc.). I reserve the right to ask students to leave if they disrupt the learning experience of their classmates.

Policy on Cooperation

I consider it advantageous if students cooperate with each other on homework and other course-related items. In fact, I encourage students very strongly to meet up with each other for regular discussions and to tackle assignments together.

However, I require that each student turn in their own (hand- or computer-written) version of each homework and assignment. Also, NO cooperation is allowed on the Midterm and Final Exams – everybody has to do ALL of the work her/himself. I consider it unethical and a violation of the honor code to copy the solution of a homework problem or an Exam verbatim from another student's solution or from a book. All material used (other than informal discussions) must be properly cited.

In this context, I want to remind everyone of the **University policy**: Any official sanction for cheating, including the assignment of a grade of F for a quiz or for a course as a penalty for cheating, will appear on the student's permanent academic transcript.

Accommodation Statement

Students are encouraged to self-disclose disabilities that have been verified by the Office of Educational Accessibility by providing Accommodation Letters to their instructors early in the semester in order to start receiving accommodations. Accommodations will not be made until the Accommodation Letters are provided to instructors each semester.

Tentative Schedule PHYS722/822

Date	Day	Time	Topic	Pages PRSZ	Pages DFHMS	Pages Wong	HW Set Due
28-Aug	Tue	1:30 - 2:45	Introduction: Basic building blocks of matter	1 - 7	1 - 7	1 - 7	
30-Aug	Thu	1:30 - 2:45	Global Properties of Nuclei: mass, charge, size, spin	11 -	333 -	7-20,119-139	
4-Sep	Tue	1:30 - 2:45	Liquid Drop model, stability, decays	- 40	-	139 - 154	
6-Sep	Thu	1:30 - 2:45	Nuclear Models - Fermi Gas	303 - 308	-	154 - 158	1
11-Sep	Tue	1:30 - 2:45	Nuclear Models - Shell Model	308 - 319	-350	235 - 272	
13-Sep	Thu	1:30 - 2:45	Introduction to Scattering: Fundamentals, Experiment	41 - 48	151 -		2
18-Sep	Tue	1:30 - 2:45	Introduction to Scattering: Fermi -> Feynman	48 - 53	- 160		
20-Sep	Thu	1:30 - 2:45	Electromagnetic Scattering off Nuclei	55 - 74	160 - 171	105 - 112	3
25-Sep	Tue	1:30 - 2:45	Elastic scattering off hadrons	75 - 86	188 - 210	113 - 115	
27-Sep	Thu	1:30 - 2:45	Resonance Excitations	87 - 90	211 -	115 -	4
2-Oct	Tue	1:30 - 2:45	Deep Inelastic Scattering	90 - 101, 157 -	-	119	
4-Oct	Thu	1:30 - 2:45	The Quark-Parton Model	-163, 270 - 274	-230	21 -	
9-Oct	Tue	No class	***Fall Break***				
11-Oct	Thu	1:30 - 2:45	Current Quarks, Gluons, Color	103 -	77 -	-	5
16-Oct	Tue	1:30 - 2:45	QCD [Take-home Midterm due]	-	-	-	
18-Oct	Thu	1:30 - 2:45	Asymptotic freedom, pQCD; DGLAP, running coupling	-138	-	-	
23-Oct	Tue	1:30 - 2:45	Confinement	215 - 232	-103	-	
25-Oct	Thu	1:30 - 2:45	Mesons	233 - 239	31 - 36	-	
30-Oct	Tue	1:30 - 2:45	Baryons	253 - 270	36 - 50	-	6
1-Nov	Thu	1:30 - 2:45	Nucleon Structure from low to high resolution		103 - 150	-56	
6-Nov	Tue	1:30 - 2:45	NN scattering	287 -	285 - 291,	80-95,409-422	7
8-Nov	Thu	1:30 - 2:45	NN forces	-	275-280,293-306	57 -	
13-Nov	Tue	1:30 - 2:45	Deuteron	-	281-285,291-293	-103	8
15-Nov	Thu	1:30 - 2:45	(Light) Nuclei	-301	307 - 332	355 - 366	
20-Nov	Tue	1:30 - 2:45	Leptons and Gauge bosons, Electroweak IA	139 - 154	51 - 55	22 - 25	9
22-Nov	Thu	No class	***Thanksgiving Holiday***				
27-Nov	Tue	1:30 - 2:45	Parity, C, T [Participation Project Due]	154 - 157	103 - 110	184 - 189	
29-Nov	Thu	1:30 - 2:45	Neutrinos	167 - 184	67-76,481-522	366 - 373	10
4-Dec	Tue	1:30 - 2:45	Higgs mechanism	185 - 211	51 - 61		
6-Dec	Thu	1:30 - 2:45	Weak decays	239-251,274-285	61 - 66	181 - 204	11
13-Dec	Thu	12:30 - 3:30	**FINAL EXAM DUE (take-home)**				