Theoretical Physics

Application of mathematical methods to classical, statistical, relativistic, and quantum mechanics, as well as electromagnetic theory. Emphasis is on revealing fundamental structure and connections. The powerful theoretical techniques learned serve as excellent preparation for graduate study in physics, astrophysics, and related fields such as engineering.

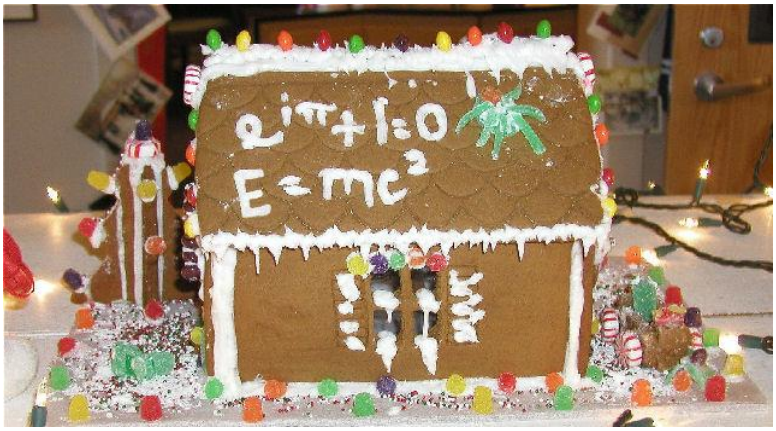
Prerequisite: Calculus II (MATH 192) or permission of the instructor.

Instructor: Michael J. Ruiz, Ph.D. in theoretical physics from the University of Maryland.

January 2020

Monday	Tuesday	Wednesday	Thursday	Friday
		1	2	3
6	7	8	9	10
13	14 A. Rotation Matrix, Groups	15	16 B. What is e? Integral Tricks	17 Last Day to Drop/Add
20 	21 C. Relativity and Four Vectors	22	23 D. Maxwell's Equations	24
27	28 E. E&M Four Potential	29	30 F. Wave Equation	31

Text: Theoretical Physics by Michael J. Ruiz **Lectures:** YouTube (doctorphys)



February 2020

Monday	Tuesday	Wednesday	Thursday	Friday
3	4 G. Ideal Gas Law	5	6 H. Statistical Mechanics	7
10	11 I. Schrödinger Equation	12	13 J. Spinors	14 
17	18 Exam 1 (A-G)	19	20 K. Pauli Equation	21
24	25 L. Dirac Equation	26	27 M. Orthogonal Functions	28

Class Meetings: Rhoades-Robinson (RRO) Hall 125 from 3:15 to 4:30 pm.

Class Responsibilities and Resources

1. Moodle Website: **http://learnonline.unca.edu/** This link is to Moodle at UNC Asheville.

2. Text: **Theoretical Physics**

3. Videos: **YouTube** **(doctorphys)**

4. Homework: Homework sets are due before class starts on the class that is two letters beyond. Fo example Homework for Class A is due Class C; Class B is due Class D, etc.

5. Office Hours: RRO 114/124, T, R 11-11:45, W 10:45-11:45,1:00-2:00 until last lecture day.

6. The Forum: Help your peers out with assignments on our 24/7 online discussion forums.

7. Gingerbread Math (2004): Best Decorated **Gingerbread Prize** for Rhoades-Robinson Hall.

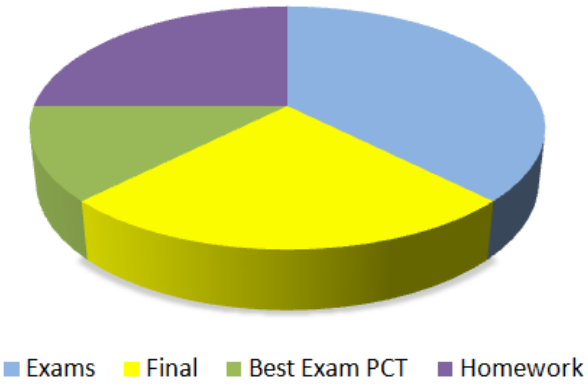
Insight into three important math-physics formulas.

$$A=\pi r^2 \qquad E=mc^2 \qquad e^{i\pi}+1=0$$

March 2020

Monday	Tuesday	Wednesday	Thursday	Friday
2	3 N. Dirac Delta Function	4 Last Day to Withdraw is March 6	5 O. Fourier Series	6
9 Spring Break	10 Spring Break	11 Spring Break	12 Spring Break	13 Spring Break
16 	17 P. Fourier Transforms	18 	19 Q. Laplace Transforms	20
23	24 Exam 2 (H-N)	25	26 R. Convolution	27
30	31 S. Cauchy Integral Formula			

Grading



Borderline Cases: If your grade is near the borderline (10 points away), I will consider helping you if you have come to 90% of the classes and have turned in 90% of the homework. In addition, I may look for a strong performance on the Final Exam, depending on the grade sought after.

100	Exam 1
100	Exam 2
100	Exam 3
200	Final
100	Best Exam Percentage
200	Homework (Due on Tuesdays)
800	**Total** (No ± Grades, See Right)

A (740-800) - apply knowledge in new areas
B (660-739) - apply knowledge in familiar areas
C (580-659) - apply knowledge in easy areas
D (500-579) - misconceptions in principles
F (0-499) - serious gaps in understanding

UNCA Snow: Announcements at UNCA website, check your email, 828.258.7985.

April 2020

Monday	Tuesday	Wednesday	Thursday	Friday
		1 	2 T. Residue Theorem and Poles	3
6	7 U. Green's Functions	8	9 V. Transfer Functions	10
13	14 Exam 3 (O-T)	15	16 W. Principle of Least Action	17
20	21 UGR Symposium No Day Class	22 	23 X. EM Field Tensor	24
27	28 Y. Einstein and Light	29 Reading Day	30 Final Exam Week Begins	

How to Succeed in Theoretical Physics

1. Time. Reserve at least 3 hours (organizing your notes, study, working practice problems, doing homework, etc.) for every hour of class. This amounts to at least 9 hours per week in addition to class time. If you are a full-time student and have a job, you should NOT work more than 15-20 hours per week.

2. Instructor. Drop by during office hours if you are confused.

3. Peers. Ask your classmates for help on the *Discussion Forums* on our website and offer help to others. You master the material when you are challenged to explain it to someone else.

4. Physics. Come to every class and take notes. Do not fall behind! As my senior high school math teacher once said, the best way to study math is with pencil in hand. Same goes for physics. Write things out. If your notes are sloppy, recopy them. If you miss a class, check to see if any Notes or YouTube videos are posted for that class and get class notes from a friend to immediately make up the material. Otherwise, you will quickly get lost.

5. Homework. Always state the problem in some way, be neat, do on scrap paper first, never cross out on the version you turn in, and explain your steps so a fellow student can follow. Make sure you write dark and large enough for easy reading. For each question you get +4 for stating the problem and showing all steps with occasional comments, +4 for mathematical and notational accuracy, +2 for neatness (which includes proper handwriting size and legibility).

May 2020

Monday	Tuesday	Wednesday	Thursday	Friday
				1
4	5 Final Exam (A-Y) 11:30 – 2:00	6 Final Exam Week Ends	7	8
 11	12	13	14	15
18	19	20	21	22
 25	 26	27	28	29

Theoretical Physics (Math Physics)

A general *Theoretical Physics* course is sometimes called Mathematical Physics or Math Physics. Such a course focuses on the mathematical methods employed across many areas of physics, engineering, and related fields. We learn the "tools of the trade" and how to use them. This aim makes our course very powerful as these mathematical tools are used in so many fields, even those outside physics such as economics. A graduate with such knowledge has the power to work in diverse fields.

Richard Feynman (1918-1988)
Courtesy nobelprize.org

Finally, *theoretical physics* teaches you elegant tricks and offers you deep insight into physics. Richard Feynman, America's most colorful physicist for many years, often pointed out the importance of theoretical physics and using innovative mathematical methods to see things from different points of view. He was often described as a magician when it came to applying mathematics to physics.

This course follows in this spirit, teaching you "magical" math tricks and shortcuts. We also present elegant formulations of the laws of physics, giving you a better appreciation of the power and beauty of physics.

UNCA-WIDE Important Information

Title IX and Sexual Misconduct. [Note that the legal term "Responsible Employee" appearing below means "Mandatory Reporter."] Title IX of the Education Amendments of 1972 prohibits sex discrimination against any participant in an educational program or activity that receives federal funds. The act is intended to eliminate sex discrimination in education. Title IX covers discrimination in programs, admissions, activities, and student-to-student sexual harassment, sexual exploitation, interpersonal violence, non-consensual touching, and sexual assault. UNC Asheville's policy against sexual misconduct extends not only to employees of the university but to students as well. If you encounter unlawful sexual misconduct behavior or gender based discrimination, please talk to any University Responsible Employee (Mandatory Reporter). All University employees (except Health and Counseling center employees and employed Campus Ministers are considered Responsible Employees (Mandatory Reporters) and are mandated to report incidents to the Title IX Office.

The Title IX office consists of Dr. Jill Moffitt, UNC Asheville's Title IX Administrator, who can be reached at (828)232-5658. Individuals may also report anonymously at https://police.unca.edu/anonymous-report. For more information regarding Title IX and resources please visit https://titleix.unca.edu/.

UNCA Chief of Police: Chief Eric Boyce.

Accommodations and Academic Accessibility. UNC Asheville values the diversity of our student body as a strength as a critical component of our dynamics community. Students with documented special needs may require accommodations due to facilities, course design, technology used, or other campus resources. Students who experience a barrier to full access to this class should let the professor know and/or make an appointment to at the Office of Academic Accessibility as soon as possible at the beginning of the semester. All information will remain confidential. For more specific information please contact the Office of Academic Accessibility at *(828)232-5050* or academicaccess@unca.edu, visit them in the OneStop Student Services Center or at their website https://oaa.unca.edu/.

Early Alerts. Faculty at UNCA are encouraged to use the university's Early Alert system to communicate with students about their progress in courses. When a faculty member submits an early alert that expresses a concern, the student receives an email from OneStop, completing a form as part of the process. It is in the student's best interest to complete the EA process quickly, as students who do so are more likely to earn credit for the course. Failure to complete the EA process (including meeting with the professor and submitting the required form to OneStop) will result in a registration hold; the student won't be able to register for the next semester's classes until they have met with the faculty member and turned in the required form. Questions about the EA system can be directed to Anne Marie Roberts (amrober1@unca.edu) in OneStop.

Team to Help Students Stuggling: https://dos.unca.edu/concerned-about-student

Academic Dishonesty. Note that any violations of academic dishonesty must be reported to the Provost's Office.