

PHYS 324
Modern Physics
Fall 2022

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| <u>Instructor:</u> | Dr. Can Ataca |
| E-mail: | ataca@umbc.edu (expect a response in 48 hours, excluding breaks and weekends) |
| Office: | PHYS 315 |
| Office hours: | Wednesdays 10:50-12:00 or by appt |
| <u>Prerequisite:</u> | PHYS 224 (Vibration and Waves) |
| <u>Lecture Hours:</u> | Monday, Wednesday, Friday 10:00-10:50 AM |
| <u>Classroom:</u> | PHYSICS 201 |
| <u>Textbook:</u> | J. R. Taylor, C. D. Zafiratos, M. A. Dubson, <i>Modern Physics for Scientists and Engineers</i> , ISBN: 978-1-938787-75-1 (Recommended) J. S. Townsend, <i>Quantum Physics-A Fundamental Approach to Modern Physics</i> , ISBN: 978-1-891389-62-7 (Recommended) D. J. Griffiths, <i>Introduction to Quantum Mechanics</i> , ISBN: 978-1107179868 |

Course Objectives: This course will introduce the basic concepts, theory and applications of modern physics, with the emphasis on relativistic and quantum physics. We will talk about special relativity, basic quantum mechanics, solid state and nuclear physics. We will discuss the key experiments and develop a fundamental understanding of the principles and laws of the different branches of physics. Some math will be involved, but the emphasis in the homeworks will be not on solving the standard quantitative problems but rather on learning the important physical concepts and the development of scientific reasoning skills.

At the end of this course, you should:

1. Understand the ideas and consequences of the theory of special relativity.
2. Understand the importance of quantum mechanics to explain nanoscale phenomena with important historical steps of its development.
3. Understand how electrons behave in different environments at nanoscale.
4. Have a better understanding of how different branches of physics such as statistical mechanics, condensed matter and nuclear physics are related with each other.
5. Broaden and deepen your physical scientific reasoning and problem-solving skills.

Grading:

Your final grade will be determined by:

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| Final Exam: | 25% |
| Mid-Term Exam: | 20% |
| Quizzes: | 4 x 4% |
| Homework: | 10 x 2% |
| Term Project: | 15% |
| Attendance: | 4% |

%75 of attendance is mandatory for a passing grade. Your letter grade will depend on the total score. If your total grade is:

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| ≥ 85 , your letter grade will be | “A” |
| $85 > X \geq 70$, then | “B” |
| $70 > X \geq 60$, then | “C” |
| $60 > X \geq 50$, then | “D” |
| $50 > X$, then | “F” |

Please focus on learning the material rather than the grades.

Midterms and Final Exam: One mid-term exam will take place during scheduled class time, in the week of October 17th, 2022. This date may be subject to change. The exam will include all discussions up to “Matter Waves” (Course 18) indicated in the “Topics to be covered” section.

The date of the final exam is determined by the university, and it will be on December 19th, 2022 (10:30 AM-12:30 PM). The exam will include all the course material covered up to the day of the exam, if not informed otherwise.

All of the exams will be closed book. At least one question of the exam will be similar to the ones assigned in homeworks. You may bring one page of **YOUR OWN** hand-written notes to any exam (no photocopies or print-outs are allowed).

Homework: Your preliminary homework for every class is to read the corresponding chapter/sections of the book. Please check the “Topic to be covered” section for the tentative timelines of each course. Homework assignments will be available on the Blackboard page every Friday and are due at the beginning of the class the following Friday, unless you are told otherwise (except holidays). You are encouraged to study in groups and discuss the material and homework questions among yourselves. However, the homework solution should be your own work, not a group product. Homework that are more than two days late will not be accepted for a grade. Late work will be discounted 10% per day late. I plan to assign weekly (~a total of 13) homeworks each having up to 3 questions. The top 10 highest graded

homeworks will be counted towards your grading. This is meant to allow for things that come up unexpectedly.

Quizzes: There will be 5 quizzes. Quizzes will be closed book/notes. They might take place any time during the class and related closely with the homework assignments. They will not be longer than 25 minutes. They will be related to the topics covered in that chapter of the book. The top 4 highest graded quizzes will be counted towards your grading. This is meant to allow for things that come up unexpectedly.

Term Projects: Every student will choose a subject to work on. The students will work in pairs of two. Please send me an email with your choice of top 3 topics given below before September 9th, 2022. I will assign the final team members for each topic. Your group will write a detailed report on your chosen subject (8-page manuscript in two columns at most) and present your subject within a class-hour. You will also prepare a 2 question-homework set for your subject. The deadline for the term project is the last week of November and the first week of December, respectively. Your final grade will be based on %45 – report, %45 -in class presentation, %10 on the homework questions.

Term project topics: Molecules, Solids-Theory, Solids-Applications, The Structure of Atomic Nuclei, Radioactivity and Nuclear Reactions, Elementary Particles.

Course Material: All of the course materials including recorded lectures and slides, homeworks and quizzes will be uploaded to the Blackboard page of the course. Your duty is to check the Blackboard regularly.

Topics to be covered:

| Courses | Chapter | Subject |
|---------|---------|--|
| 1-5 | 1 | The Relativity of Space and Time |
| 6-9 | 2 | Relativistic Mechanics |
| 10-13 | 3 | Quantum Mechanics-Atoms |
| 14-15 | 4 | Quantization of Light |
| 16-17 | 5 | Quantization of Atomic Energy Levels |
| 18-20 | 6 | Matter Waves |
| 21-24 | 7 | The Schrodinger Equation in One Dimension |
| 25-28 | 8 | The Three-Dimensional Schrodinger Equation |

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| 29-30 | 9 | Electron Spin Theory |
| 31-33 | 10 | Multi-electron Atoms; the Pauli Principle and Periodic Table |
| 34-36 | 11 | Atomic Transitions and Radiation |
| 37-39 | 12-14 | An Introduction to Solid State Physics |
| 40-42 | 16-18 | An Introduction to Nuclear Physics |

Student Responsibilities:

- Students are responsible for checking their academic e-mails and the Blackboard page of the course daily for getting updates about the course, grades, homeworks and class notes.

- If you need to take a make-up exam, please provide a university-approved excuse (such as a nurse/doctor signed document).

- In order to be successful in this course, you should attend all classes by having read the background material. Please be attentive and take notes during lectures. You are welcome to ask questions to clarify any point that is not clear, either during class or during my office hours. Please complete all homework on time and prepare for the exams.

COVID-19: Safety Expectations and Guidelines:

UMBC has set clear expectations for masking while on campus that include the requirement that you must wear a face mask that covers your nose and mouth in all classrooms regardless of your vaccination status. This is to protect your health and safety as well as the health and safety of your classmates, instructor, and the university community. Anyone attending class without a mask or wearing one improperly will be asked by the instructor to put on a mask or fix their mask in the appropriate position. Any student that refuses to comply with this directive will be asked to leave the classroom immediately and failure to do so will result in the instructor requesting the assistance of the University Police. Students who refuse to wear masks may be referred to Student Conduct and Community Standards and may face disciplinary action for violations of the Code of Student Conduct, specifically, Rule 2: Behavior Which Jeopardizes the Health or Safety of Self or Others and Rule 16: Failure to Comply with the Request of a University Official. UMBC's on-campus safety protocols, including masking requirements, are subject to change in response to the evolving situation with Covid-19.

Covid-related Classroom Absences:

We recognize that in addition to physical illness due to COVID-19, there are numerous COVID-19-related situations that might also necessitate absence from class. This includes situations like, but not limited to, self-quarantine, quarantine or care of immediate family members, or child care resulting from school closures or family illness. Class absences may take the form of not attending an in-person class or a scheduled synchronous online class; or not participating in online class activities (synchronous or asynchronous). Students who are absent from class due to COVID-19-related situations are expected to communicate directly with the course instructor. Students should submit notification of the absence in writing to their instructor either prior to the absence or as soon afterwards as possible. If the COVID-19 related absence coincides with graded work (e.g., homework, in-class activities, quizzes, presentations, activities, etc.), students should work with the instructor to arrange for an academic accommodation.

It is important to remind you that class absences, COVID-19-related or not, do not alter the academic requirements of any course and students remain responsible for information and material missed during the absence. Additionally, COVID-19-related absences are not considered a “disability” and as such do not require that students seek accommodations from the Office of Student Disability Services.

Finally, an instructor may determine that missing a certain amount of participation-dependent activities precludes successful accomplishment of the learning outcomes for the course. In cases like this, the instructor may advise the student to withdraw from the course. Students should discuss all options with their instructor and if course withdrawal is necessary, students should work with their [academic advisor](#), and for undergraduates, if appropriate, their [academic advocate](#) to minimize impacts on their degree progression. Graduate students may also contact their [graduate program director](#).

Classroom Management:

Since physical distancing is a key campus safety measure, classrooms have capacities that limit attendance to allow for distancing. The occupancy limit will be posted outside the classroom. Instructors may distribute students within the classroom or rearrange the furniture for pedagogical purposes as long as occupants can maintain a minimum of three feet of physical distancing. If furniture is moved it should be returned to its original location for the next class. Additional information on UMBC’s guidance on physical distancing is available [here](#).

Cleaning supplies will be available in each classroom. These supplies include disinfecting wipes or spray bottles with paper towels. The wipe dispensers have stickers on them with the work control number for Facilities Management so that faculty can call if there is any problem with the dispensers. They will also be checked on a daily basis. Instructors should encourage students to wipe down their seats and work surfaces before the class begins. If there are concerns about chemical sensitivity to the classroom cleaning materials, please reach out to the Office of Environmental Safety and Health. Classroom windows should not be opened as this has the potential to disrupt the operation of the building HVAC system.

Technology: Access, Requirements, Resources, Support:

To help ensure that UMBC students are equipped for academic success, the Division of Information Technology (DoIT) provides a wealth of resources and support, including tips for getting online and minimum specifications to consider when purchasing a computer (doit.umbc.edu/students). UMBC does require all students to be technologically self-sufficient, which entails having a reliable personal computer (preferably a laptop with webcam) and Internet access. Since UMBC requires all students to have a computer and Internet access, financial aid may be used to meet this requirement. To learn more, students should contact their financial aid counselor at financialaid.umbc.edu/contact.

Statement of Values for Student Academic Integrity at UMBC

In February 2001, the Faculty Senate affirmed the importance of our values and practices by adopting the Statement of Values for Student Academic Integrity that is placed on most course syllabi:

Academic integrity is an important value at UMBC. By enrolling in this course, each student assumes the responsibilities of an active participant in UMBC's scholarly community in which everyone's academic work and behavior are held to the highest standards of honesty. Cheating, fabrication, plagiarism, and helping others to commit these acts are all forms of academic dishonesty, and they are wrong. Academic misconduct could result in disciplinary action that may include, but is not limited to, suspension or dismissal.

The purposes of higher education are the learning students and faculty undertake, the knowledge and thinking skills developed, and the enhancement of personal qualities that enable students to be strong contributing members of

society. In a competitive world, it is essential that all members of the UMBC community uphold a standard that places integrity of each student's honestly earned achievements above higher grades or easier work dishonestly sought.

All members of the UMBC community are expected to make a commitment to academic honesty in their own actions and with others. Academic misconduct can result in disciplinary action that may include suspension or dismissal. The following are examples of academic misconduct that are not tolerated at UMBC:

- **Cheating:** Using or attempting to use unauthorized material, information, study aids, or another person's work in any academic exercise.
- **Fabrication:** Falsification or invention of any information or citation in an academic exercise.
- **Facilitating academic misconduct:** Helping or attempting to help another student commit an act of academic misconduct.
- **Plagiarism:** Knowingly, or by carelessness or negligence, representing as one's own, in any academic exercise, the intellectual or creative work of someone else.
- **Dishonesty:** Lack of truthfulness or sincerity when interacting with the faculty member regarding an academic exercise

To this end, UMBC undergraduate students also adopted the following Undergraduate Honor Statement as it describes the high standards to which everyone in the community will be held:

I hereby assume the responsibilities of an engaged member in a scholarly and civic community in which academic work and behavior are held to the highest standards of honesty. It is my active participation that affirms these principles and gives them true meaning as well as value in my education. I realize that by committing acts of dishonesty I hurt myself and place an indelible mark on the reputation of UMBC. Therefore, I will not cheat, fabricate materials, plagiarize, or help another to undertake such acts of academic dishonesty, nor will I protect those who engage in acts of academic dishonesty.

For more information on the topic of Academic Integrity, visit:

<http://oue.umbc.edu/ai/>

Accessibility and Disability Accommodations, Guidance and Resources:

Accommodations for students with disabilities are provided for all students with a qualified disability under the Americans with Disabilities Act (ADA & ADAAA) and Section 504 of the Rehabilitation Act who request and are eligible for accommodations. The Office of Student Disability Services (SDS) is the UMBC

department designated to coordinate accommodations that would create equal access for students when barriers to participation exist in University courses, programs, or activities.

If you have a documented disability and need to request academic accommodations in your courses, please refer to the SDS website at sds.umbc.edu for registration information and office procedures.

SDS email: disAbility@umbc.edu, SDS phone: (410) 455-2459

If you will be using SDS approved accommodations in this class, please contact me (instructor) to discuss implementation of the accommodations. During remote instruction requirements due to COVID, communication and flexibility will be essential for success.

Sexual Assault, Sexual Harassment, and Gender Based Violence and Discrimination:

UMBC's **Policy on Sexual Misconduct, Sexual Harassment and Gender Discrimination** and Federal Title IX law prohibit discrimination and harassment on the basis of sex in University programs and activities. Any student who is impacted by sexual harassment, sexual assault, domestic violence, dating violence, stalking, sexual exploitation, gender discrimination, pregnancy discrimination, gender-based harassment or retaliation should contact the University's Title IX Coordinator to make a report and/or access support and resources:

Mikhel A. Kushner, Title IX Coordinator (she/her/hers)
410-455-1250 (direct line), kushner@umbc.edu

You can access support and resources even if you do not want to take any further action. You will not be forced to file a formal complaint or police report. Please be aware that the University may take action on its own if essential to protect the safety of the community.

If you are interested in or thinking about making a report, please see the **Online Reporting Form**. Please note that, while University options to respond may be limited, there is an anonymous reporting option via the online form and every effort will be made to address concerns reported anonymously.

Notice that Faculty are Responsible Employees with Mandatory Reporting Obligations:

All faculty members are considered *Responsible Employees*, per **UMBC's Policy on Sexual Misconduct, Sexual Harassment, and Gender Discrimination**. Faculty are therefore required to report possible violations of the **Policy** to the Title IX Coordinator, even if a student discloses something they experienced before attending UMBC.

While faculty members want you to be able to share information related to your life experiences through discussion and written work, students should understand that

faculty are required to report Sexual Misconduct to the Title IX Coordinator so that the University can inform students of their **rights, resources and support**.

If you need to speak with someone in confidence, who does not have an obligation to report to the Title IX Coordinator, UMBC has a number of **Confidential Resources** available to support you:

- The **Counseling Center**: 410-455-2472 / After-Hours 410-455-3230
- **University Health Services**: 410-455-2542
- Pastoral Counseling via **Interfaith Center**: 410-455-3657;
interfaith@umbc.edu

Other Resources:

- **Women's Center** (for students of all genders): 410-455-2714;
womenscenter@umbc.edu.
- **Shady Grove Student Resources, Maryland Resources, National Resources**.

Child Abuse and Neglect:

Please note that Maryland law and **UMBC policy** require that I report all disclosures or suspicions of child abuse or neglect to the Department of Social Services and/or the police.