University of Houston-Clear Lake

PHYS 3303-01 Modern Physics (Summer 2015) Syllabus
3:00-5:50pm (TWR) @ Bayou 3324

Quality Enhancement Plan (QEP) Applied Critical Thinking for Lifelong Learning and Adaptability

Applied Critical Thinking Statement: This course has been authorized by UHCL as an Applied Critical Thinking (ACT) Course which means that in addition to learning about the specified course content, students will be engaged with some or all of the Elements of Thought and Universal Intellectual Standards of critical thinking. The objective of an ACT course is to develop the student's ability to become skilled at analysis and evaluation by applying a set of intellectual tools that may be effectively used across all disciplines (as well as to the student's personal life). Based on the Foundation for Critical Thinking model (http://www.criticalthinking.org/), critical thinking involves thinking for a *purpose*, asking *questions*, using *information*, applying *concepts*, drawing *inferences and conclusions*, identifying *assumptions*, anticipating *implications and consequences*, and recognizing *points of view*. The Universal Intellectual Standards that are applied to these Elements of Thought of critical thinking in order to develop Intellectual Traits include *clarity*, *accuracy*, *precision*, *relevance*, *depth*, *breadth*, *logic*, *significance*, and *fairness*.

How Critical Thinking is Present in Modern Physics:
Modern Physics is comprised of Relativity, Quantum mechanics and their applications to different areas of physics such as astrophysics, space physics, nuclear and particle physics as well as condensed matter physics. Relativity and Quantum Mechanics are intermingled in all aspects of modern developments in physics ranging from the small scale subatomic physics to large scale structure formation in astronomy. They are fundamental and powerful concepts that students should be able to apply to solve physics problems and laboratories in an appropriate manner. In all of these examples, the student of Physics should be asking, "What are the *relevant basic principles of Physics which* I need to apply to understand why things work the way they are?" They also learn the relevant data analysis techniques to draw *accurate inferences and conclusions from the modern physics experiments including quantum mechanics and relativity.*

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Office hour: TR 4:00 -5:30pm or by appointment

Textbook: Modern Physics, by Kenneth Krane (Third Edition) Wiley (2012)
ISBN# 978-1-118-06114-5 (hardback)

Prerequisite: University Physics I and II or Equivalent

Catalogue Description: An introduction to topics in modern physics, Fundamental concepts of quantum physics and relativity. Applications to atomic structure and spectra, black body radiation, solid state physics, and nuclear and particle physics.

Modern Physics Course Description: Physics as a subject plays an integral role in understanding the modern approach of physical systems at the subatomic level. It also explains the effect of extremely high speeds on observation. So the correct information through direct measurements are not possible for rapidly moving objects in space or at subatomic levels and special techniques are developed for extremely large or minutely small systems. Students learn the corresponding techniques of relativity and quantum mechanics to fully describe the relevant systems and to be able to incorporate missing information due to the observational defects. Extraction of correct information from all the measurements for directly inaccessible systems is only possible by incorporation of quantum mechanics for minute systems and relativistic approach for rapidly moving spatial bodies. Applications of modern approach to atomic structure and spectra, black body radiation, solid state physics, and nuclear and particle physics.

Learning Outcomes: After the completion of this course, students will be able to

1. Demonstrate the basic ***concepts clearly*** of relativity and quantum mechanics in the light of fundamental laws of physics.
2. Learn how to relate and apply the concepts of relativity and quantum mechanics to *relevant* physical systems.
3. ***Accurately and precisely infer*** the basic mathematical techniques to demonstrate and prove the validity of quantum mechanics to understand atomic and subatomic systems
4. *Demonstrate* the application of special relativity in heavenly bodies along with gravity.
5. Understand a relationship between the Basic concepts of modern physics and the ***relevant experimental data (information)*** and computational analysis to prove the validity of a theory and develop a theory based on the data analysis.
6. Learn about the nuclear models, nuclear reactions and nuclear radiations and learn about some well-known experiments on the topic.
7. Conduct at least one visit to the research laboratories in the area to get a better exposure to the advanced level experimental physics that will help them to choose their future pathway.
8. Collect and organize information on a given topic through the comparative study of experimental results from different labs and present it to the class.

Major Assignments:

(SLO 1): Regular Quizzes will be given based on conceptual questions and simple mathematical calculations that identify student's comprehension of concepts clearly. Students are required to pass at least 60% of these quizzes. Quizzes will contribute to 10% to your course grade.

(SLO 3): Students will be expected to calculate precisely and accurately the problems included in exams and will receive full credit only if the intermediate steps are shown clearly.

(SLO 5): Students will collect relevant data from their experiments (performed in a group) and analyze experimental data to prove the relevant physical concepts. This will help them to find a *connection* between theoretical concepts and physical applications of theory.

Fundamental and Powerful Concepts (FPC) of the Course

In ACT vocabulary, fundamental and powerful concepts form the foundation that permeates and unites a course. In this course, such concepts are:

1. Conceptual modeling for thoroughly understanding and precisely specifying problem requirements, assumptions, and constraints.
2. Theoretical design for constructing mathematical solution to satisfy the data model.
3. Data manipulation for updating and accessing information and testing the design.
4. Application of theoretical/conceptual model to real physical systems

Assessment and Critical Thinking Activities

Critical thinking is generally part of all the assessment activities including problem solving in homework and exams. However, there are two specially designed assessment activities (AA) of critical thinking in the course. The evaluation of these activities is used to assess how well critical thinking is incorporated into the course. These assessments will be used as input to the UHCL Critical Thinking database for internal assessment of Critical Thinking, and will not affect the grade of the course.

1. *Quiz # 3*: Student will use homework No 1 on relativity to learn basic concept of special relativity and then design a project to find out type of special and temporal transformations are needed to interpret the observations of spacecraft on Earth. . This homework requires the students to have a precise conceptual understanding of principles of special relativity and then use modeling and normalization theory to infer and construct an effective set of transformation equations.
2. *Homework No. 3*: Develop a theoretical application using mathematical equations and already existing empirical results. The students will explore and analyze data and interface requirements of the Website and develop SQL queries to provide the required data questions.

Of the four C's (curiosity, connections, creativity and communication), these assessments focus on connections. The related Student Learning Outcomes (SLO) and Fundamental and Powerful Concepts (FPC):

Activity	SLO	FPC
AA #1	1,3	1,2

AA #2	5	3,4

The assessment criteria for the AA:

Assessment Activity	Assessment Outcome		
	Unacceptable	Acceptable	Excellent
AA #1	[0%,80%)	[80%,90%)	[90%,100%]
AA #2	[0%,80%)	[80%,90%)	[90%,100%]

Overall, if 70% or above of students are evaluated to be acceptable or excellent in each activity, as well as the average of all activities, the outcomes will be deemed acceptable. Overall, the instructor will evaluate the ACT content, activities, and assessment of the course and make necessary adjustment.

Quizzes: Short Pop quizzes will be given during the class throughout the semester. There will absolutely be no make-up to them even if you miss the quiz being late in the class for some time. You have to be in the class at the time of the quiz.

Exams: Midterm: June 17
Final: As per schedule

Grading: A solution (homework, exam) that presents nothing more than a restatement of the problem will receive zero credit. Partial credit will be given, with the score of an individual problem ranging between zero and full credit. Credit will be given for clarity of presentation; *illegible work will not be graded.* For the final grade, homework, exams, etc. will be weighted as follows:

Homework: 20%
Quizzes: 10%
Midterms: 40%
Final Exam: 30%

Final letter grade assignment:

A: 92.5–100
A-: 89.5 - 92.4
B+: 86.5 - 89.4
B: 82.5 - 86.4
B-: 79.5 - 82.4
C+: 76.5 - 79.4
C: 72.5 - 76.4
C-: 69.5 - 72.4
D+: 66.5 - 69.4
D: 62.5 - 66.4
D-: 59.5 - 62.4
F: 00.0 - 59.4

Instructional Methodology: This course will utilize chalkboard and PowerPoint slides in lectures, combined with class discussion and problem solving sessions led by the instructor.

Course policies: Attendance is expected in all classes. Active class participation will be appreciated. Questions, comments are welcome in the class. A missed exam will receive zero credits unless the instructor is notified by email, phone, etc. and the instructor is ready to give a makeup exam. Doctor's note may be required for medical excuse. Make-up exams, if there are any, will be individually scheduled with the student.

Attendance Policy: Attendance is usually not taken in class, but **you are responsible for ALL information given in class, including assignments, notes, changes to the syllabus, etc**. Attendance is important to success in this course. Each student is responsible for all material covered and assignments due even when absent.

Make-ups: Make-up exams are not recommended. However, under unavoidable circumstances some arrangements can be made if the instructor is informed ahead of time.

Honesty Code: I will be honest in all my academic activities and will not tolerate dishonesty.

Disability Policy: If you are certified as disabled and entitled to accommodation under the ADA, section 503, please notify the instructor as soon as possible. lf you are not currently certified and believe you may qualify, please contact the UHCL Disability Services Office at 281-283-2648 or go to their website at http://prtl.uhcl.edu/portal/page/portal/UAO/Student.

"The University of Houston System complies with Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990, pertaining to the provision of reasonable academic adjustments/auxiliary aids for students with a disability. In accordance with Section 504 and ADA guidelines, each University within the System strives to provide reasonable academic adjustments/auxiliary aids to students who request and require them. If you believe that you have a disability requiring an academic adjustments/auxiliary aid. Please contact your University's student disability services center."(SAM 01.D.09, p. 3)

This course is comprised of the following Major Topics

(i) Special Relativity

- Lorentz Frames
- Length Contraction and Time Dilation
- Synchronization of Clocks and Twin Paradox
- Doppler Effect
- Four dimensional description of space-time.
- Einstein's theory of relativity

(ii) Quantum Mechanics

- Scale of Quantum Mechanics
- Basic Postulates of Quantum Mechanics
- Wave-particle duality and uncertainty principle
- Square-well Potential
- Particle in a box
- Potential barrier and tunneling effect

(iii) Introduction to Nuclear Physics

- Nuclear Structures
- Nuclear Decays
- Nuclear Models
- Nuclear Processes

(iv) Introduction to Solid State Physics

- Crystal Structure
- Band theory
- Phase transition

(v) Recent Research Problems and Techniques

- Research areas of UHCL Physics faculty
- Possibility of special topic courses through UHCL faculty or adjuncts
- Projects of student's interest