SYLLABUS

Course Information:

PHYS 221 Section 1 [CRN# 60507] — Comprehensive Physics I — Fall 2019
Lecture: M, W & F 10:00-10:50 [Workman 109]
Recitation: W: 14:00-15:55 [Workman 109]

|**Professor:**............................Dr. David Meier, Workman 359
| Tel: 835-5340, email: david.meier@nmt.edu (preferred),
|**Office Hours:**....................M:11:00-12:00, T:14:00-15:30, Th:14:00-15:30; or by appointment
|**Class Webpage:**................kestrel.nmt.edu/∼dmeier/phys221/phys221.html

Course Description:

|**Description:** This is the first of a two semester sophomore comprehensive physics course. The subjects of focus include waves, oscillations, optics, the theory of special relativity, quantum mechanics and the connection of these topics with classical mechanics. This course is a core requirement for physics bachelors degree.

|**Pre-requisites:**.................*PHYS 121 or equivalent, MATH 131*
|**Co-requisites:**..................*PHYS 221 L*

|**General Policy:** The following class policy is designed to make your learning as effective and pleasant as possible. If a particular aspect of the policy is not working, I reserve the right to change it as we go along. However, I will do my best to be fair and give advanced notice. You are urged to communicate with me if you need to discuss class material or policy. An email is the quickest way to get ahold of me outside office hours.

Learning Outcomes:

|**Course Learning Outcomes:** Upon successful completion of this course students will be able to solve basic problems in wave mechanics, special relativity and basic quantum theory. The central outcome of this unique course is to go beyond Newtonian thinking to understand the world view from the perspective of a modern (20/21st century) physicist. Students will be able to demonstrate understanding of wave motion, interference and diffraction as well as its geometric optics limit. They will be able to explain how the analogous wave nature of matter leads to the understanding of the quantum world and from this how the geometric optics limit of quantum theory leads to Newton's laws. Students will understand the geometric approach to special relativity by being able to solve problems using the space-time diagram approach to special relativity. In addition, students will be able to apply mathematical reasoning, particularly vector analysis and calculus, to solve real world physics problems and from that develop spatial reasoning and visualization as applied to both relativistic and non-relativistic systems. Finally, the student will show that they can read the textbook *and* peer-reviewed literature with comprehension and write about them in a coherent fashion.

|**Program Learning Outcomes:** Program mission / learning outcomes are available at: http://www.nmt.edu/academics/physics/Outcomes.php

Upon successful completion of this course you will be prepared to meet your next milestones in your undergraduate study of physics.

Course Requirements:

|**Required Text:**.................*A Radically Modern Approach to Introductory Physics — Volume I; 2nd edition* — D. J. Raymond

|**Attendance / Participation:** Attendance is required for all class sessions. This includes both Lectures and Recitation. New (and required) material may be presented in any class session. Participation grades will be evaluated based on regularity of attendance and level of in class participation (both Lectures and Recitation). Significant interaction between student/instructor and student/student is expected (especially in the Recitation). Utmost effort should be made by all to handle such interactions in a respectful, supportive and friendly manner.

|**Exams:** There will nominally be four exams throughout the term. It is anticipated that exams will occur in Recitation or the finals period. All requests for make up exams must be associated with an excused absence *requested ahead of time* and require acceptable documentary proof of said excuse. The nature of the accommodation is at the discretion of the instructor. The exams will focus on new material from the previous test up to the current point. Exams will test your independent mastery of the course material so you must do the work alone. You will be permitted use of limited notes and a calculator (exact amount and form to be determined). No "smart" devices (those that can connect to the internet or to another device) are permitted in exams.

|**Homework:** The homework (HW) problems and due dates will nominally be announced at the beginning of each class lecture and on the class webpage. The HW will primarily include end of chapter textbook problems, each of equal weight. Nominally HW turned in late will lose 5% per day up to a maximum of 30%. Credit will be given up until the exam that covers that material occurs. [If you are late on an assignment please go back and do it, you can still obtain up to 70% credit.] This late HW policy may be modified, based on class consensus. Recitations will focus on working HW(-like) problems. Working in groups to solve the problems is permitted (encouraged during Recitation) but all turned in assignments must be your own work written up individually (see the academic honest policy below). HW must be written legibly and show all work in clear and followable narrative. If the grader cannot follow the train-of-thought credit will be lost.

|**Textbook / Chapter Summaries:** Material covered will follow the textbook presentation closely, however the relative focus may not be weighted the same (see Course Schedule below). The material covered is novel and likely from a different approach than seen elsewhere (if you have seen it at all). Also the textbook is terse in places, focusing directly on the key points. Therefore it is vital that you have carefully read and considered the chapter material ahead of time. To motivate this, chapter summaries will be required to be completed by the time we begin the chapter material in Lecture. The chapter summaries should be approximately 250 words in length and describe: **i)** a brief summary of the material presented in the chapter at the level of detail necessary to make it clear that the chapter was read, **ii)** a brief description of the parts of the chapter you found

most interesting, and perhaps most importantly, **iii)** identify *specific* sub-topics that you did not understand in reading the chapter. Grading of chapter summaries will be on a 0 (low) - 5 (high) scale. The grading is based on the carefulness with which i) - iii) are addressed and **not** on your level of mastery of the material. I am not particular about formatting of the chapter summaries as long as they are legible and match the above length and topic requirements. Chapter summaries **cannot** be made up (there will be no excused absences for these!). However, I will count only a subset (likely 9) of the highest scores so if you miss some it is still possible to get 100 % on the chapter summary portion of the grade

|**Reports:** This class will also include a report. You can never get too much experience writing. As budding physicists it is also key to begin to develop experience reading and understanding the physics literature. The report will serve to give you practice with both of these. You will select a *peer-reviewed* paper of historical significance (for example from the list below) then, upon approval, read it, generate a detailed outline of what you plan to write about and then write the report. The report should introduce the paper's basic physics (including background information), discuss its key discovery/result, place its significance to the field in context, and finally include some discussion of the clarity/writing style of the paper. Paper choices will be allocated on a first-come first-served basis with overlap minimized. Report outlines will be due ∼1 month after the topic choice deadline. The report should be ∼10 typed, double-spaced pages (formatting not especially important but proper citation and referencing of all supporting material is a must) and should be in "textbook style" of writing. The report will nominally be due the last week of class.

|**Lab:**
The Lecture will be heavily focused on advanced theoretical aspects of physics, leaving experimental verification to the Lab. Officially the Lab is a separate course from the Lecture. All grading issues for the Lab are entirely the providence of the Lab instructor. I cannot guarantee any direct association between the Lecture presentation and the Lab material.

Course Schedule:

The nominal (subject to change) course schedule is:

Chapter 1 .... 2 weeks
Chapter 2 .... 1 week
Chapter 3 .... 1 week
Exam I — chps 1-3
Chapters 4 & 5 [jointly] .... 3 weeks
Exam II — chps 4-5
Chapter 7 .... 2 weeks
Chapter 8 .... 1 week
Chapter 9 .... 2 weeks
Exam III — chps 7-9
Chapters 10 & 11 [selected topics] ... 2 weeks
Chapter 12 .... 1 week
Exam IV — chps 10-12

Grading:

Exams (x4) ....40 %
Homework ....30 %
Chp. Summaries (∼best 9) ....5 %
Report Outline ....10 %
Report ....10 %
Participation/Effort ....5 %

Grading Scale — A: 90 - 100 %, B: 80 - 89 %, C: 70 - 79 %, etc.
(I reserve the right to curve the grades [up only] if necessary)

University Policy Statement:

Academic Honesty: New Mexico Tech's Academic Honesty Policy for undergraduate and graduate students is found in the student handbook, which can be found at:

http://www.nmt.edu/student-handbook

You are responsible for knowing, understanding, and following this policy.

Reasonable Accommodations: New Mexico Tech is committed to protecting the rights of individuals with disabilities. Qualified individuals who require reasonable accommodations are invited to make their needs known to the Office of Counseling and Disability Services (OCDS) as soon as possible. To schedule an appointment, please call 835-6619.

Counseling Services: New Mexico Tech offers mental health and substance abuse counseling through the Office of Counseling and Disability Services. These confidential services are provided free of charge by licensed professionals. To schedule an appointment, please call 835-6619.

Respect Statement: New Mexico Tech supports freedom of expression within the parameters of a respectful learning environment. As stated in the New Mexico Tech Guide to Conduct and Citizenship: "New Mexico Tech's primary purpose is education, which includes teaching, research, discussion, learning, and service. An atmosphere of free and open inquiry is essential to the pursuit of education. Tech seeks to protect academic freedom and build on individual responsibility to create and maintain an academic atmosphere that is a purposeful, just, open, disciplined, and caring community."

Title IX Reporting: Sexual misconduct, sexual violence and other forms of sexual misconduct and gender-based discrimination are contrary to the University's mission and core values, violate university policies, and may also violate state and federal law (Title IX). Faculty members are considered "Responsible Employees" and are required to report incidents of these prohibited behaviors. Any such reports should be directed to Tech's Title IX Coordinator (Dr. Peter Phaiah, 20D Brown Hall, 575-835-5187, titleixcoordinator@nmt.edu.) Please visit Tech's Title IX Website (http://www.nmt.edu/titleix) for additional information and resources.

Candidate Report Papers for PHYS 221:

(Others may be chosen by the student with consent of instructor)

- **Michelson & Morley 1887**, American Journal of Science, 203, 22; *On the Relative Motion of the Earth and the Luminiferous Ether* — Michelson-Morley Experiment
- **Rontgen 1897**, Nature, 53, 274; *Eine Neue art von Strahlen* — Discovery of X-rays
- **Thomson 1897**, Philosophical Magazine, 44, 293; *Cathode Rays* — Discovery of the Electron
- **Planck 1901**, Annalen der Physik, 309, 553; *Uber das Gesetz der Energieverteilung im Normalspektrum* — Discovery of the Quantum
- **Einstein 1905**, Annalen der Physik, 322, 132 *Uber einen die Erzeugung und Verwandlung des Lichtes betreffenden heuristischen Gesichtspunkt* — Discovery of Light Quanta
- **Einstein 1905**, Annalen der Physik, 322, 891; *Zur Elektrodynamik bewegter Korper* — Special Relativity
- **Einstein 1905**, Annalen der Physik, 323, 639; *Ist die Tragheit eines Korpers von seinem Energieinhalt abhangig?* — Mass-Energy Equivalence
- Friedrich et al. 1913, Annalen der Physik, 346, 971; *Interferenzerscheinungen bei Rontgenstrahlen* — von Laue's X-ray scattering
- **Bohr 1913**, Philosophical Magazine, 26, 1; *On the Constitution of Atoms and Molecules* — Bohr Model of the H Atom
- **Millikan 1913**, Physical Review 1, 109; *On the Elementary Charge and the Avogadro Constant* — Millikan Oil Drop Experiment
- **Bragg & Bragg 1913**, Proceeding of Royal Society, 88, 428; *The Reflection of X-rays by Crystals* — Experimental confirmation of X ray crystal diffraction
- **Einstein 1916**, Annalen der Physik, 354, 769; *Die Grundlage der allgemeinen Relativitatstheorie* — General Relativity
- **Noether 1918**, Nachr. D. Konig. Gesellsch. D. Wiss. Zu Gottingen, Math-phys. Klasse, 235; *Invariante Variationsprobleme* — Noether's Theorem
- **Michelson & Pease 1921**, Astrophysical Journal, 53, 249, *Measurement of the Diameter of α Orionis with the Interferometer* — First Measurement of another star's size via Mich. Interferometer
- **Compton 1923**, Physical Review, 21, 483; *A Quantum Theory of the Scattering of X-rays by Light Elements* — Further proof that light acts as a particle
- **Heisenberg 1925**, Zeitschrift fur Physik, 33, 879; *Uber quantentheoretische Umdeutung kinematischer und mechanischer Beziehungen* — Matrix Mechanics
- Pauli 1925, Zeitschrift fur Physik, 31, 765; *Uber den Zusammenhang des Abschlusses der Elektronengruppen im Atom mit der Komplexstruktur der Spektren* — Exclusion Principle
- **Schroedinger 1926**, Annalen der Physik, 384, 361; *Quantisierung als Eigenwertproblem* — Wave Mechanics
- Schroedinger 1926, Annalen der Physik, 384, 489; *Quantisierung als Eigenwertproblem* — Quantum Harmonic Oscillator
- Born 1926, Zeitschrift fur Physik, 38, 803; *Quantenmechanik der Stoßvorgange* - Probabilistic interpretation of quantum mechanics
- **de Broglie 1927**, *On the Theory of Quanta*, thesis — Wave-particle duality
- **Davisson & Germer 1927**, Nature, 119, 558; *The Scattering of Electrons by a Single Crystal of Nickel* — Wave nature of electrons
- Heisenberg 1927, Zeitschrift fur Physik, 43, 172; *Uber den anschaulichen Inhalt der quantentheoretischen Kinematik und Mechanik* - Uncertainty Principle
- **Gamow 1928**, Zeitschrift fur Physik, 51, 204; *Zur Quantentheorie des Atomkernes* — Quantum Tunneling & Radioactive decay
- **Jansky** 1933, Nature, 132, 66; *Radio Waves from Outside the Solar System* — Discovery of Radio waves from space
- **Rossi & Hall 1941**, Physical Review 59, 223; *Variation of the Rate of Decay of Mesotrons with Momentum* — Experimental confirmation of Muon time dilation
- **Watson & Crick 1953**, Nature, 171, 737; *Molecular Structure of Nucleic Acids: A Structure for Deoxyribose Nucleic Acid* — Discovery of DNA Structure
- **Franklin & Gosling 1953**, Nature, 171, 740; *Molecular Configuration in Sodium Thymonucleate* — X-ray diffraction leading to DNA structure discovery
- **Pound & Rebka 1959**, Physical Review Letters 3, 439; *Gravitational Redshift in Nuclear Resonance* — Experimental confirmation of gravitational redshift
- **Mermin 1984**, American Journal of Physics, 52, 119; *Relativity without light* - The principle of relativity without recourse to light

Bold = English translations of the article are readily available