**STATE UNIVERSITY of NY COLLEGE AT BUFFALO**

**Department of Physics Course Syllabus**

**PHY 620: Mechanics CRN2529 Summer 2022
BSC Summer Physics Teachers’ Academy**

**Instructors:**  Prof. Dan MacIsaac, Rm278 Science & Math Complex (SAMC 278) Phone: (716) 878-3802 (O)

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**Emergencies/Admin:** MacIsaac is carrying a cell phone +1 (716) 909 – 2233 (24h) for the duration of PHY620.

**Course Web Page:** <http://BlackBoard.BuffaloState.Edu> (official campus LMS) and via googledocs.

**Course Particulars:** This is a 6 credit-hour graduate physics course with integrated laboratory.
Class meets daily in SAMC 359, 357 and environs 8:00am-5:00pm M-F 18 July 2022 – 5 Aug 2022
and online the following 2 weeks asynchronously / asynchronously the weeks of 8-19 Aug 2022,
with additional voluntary optional evening events.

**Pre-requisites:**

## - Physics teaching experience and/or active status in a BSC physics teaching program OR

- Permission of the instructor.

**Textbook:**

1. The **required** **electronic** text is: *Dukerich, L. et al (Ed) (2014). Modeling Instruction in High School Physics (2012). American Modeling Teachers Association: Tempe, AZ.* This complete National Science Foundation (NSF) funded high school physics curriculum is one of many owned by the AMTA and provided *only* to all AMTA members free of charge. You acquire licensed access to this curriculum by registering for AMTA membership

and ***PHY622 students will receive electronic copies of all curricula files, guides and keys both as PDF and editable word documents for classroom reproduction and use.*** The AMTA website also provides access to blogs, updates versions of materials, extensive listserv archives and active online groups discussing individual modeling activities.

1. A second required (though this one is free access in multiple formats) electronic text is Moebs,W., Ling, S.J., & Sanny, J. (2016). University Physics Volume 1. Houston: OpenStax (Rice University). Downloadable from <https://openstax.org/details/books/university-physics-volume-1> . We will largely use this for weeks 4 and 5 online content selected from Ch10-17 on rotational mechanics, gravitation, oscillations and waves.
2. An important optional reference text is:  *Arons, A. B. (1997).  Teaching introductory physics.  New York: Wiley.  ISBN 0-471-13707-3.*  This text contains three books bound together and should be the basis of any professional physics educator's library (the blue bible).  About $100 (with tax), stocked at online booksellers.  *The Arons text is referenced in PHY500, PHY620 and PHY622, though loaner copies will be available.*
3. **A final suggested reference** work is *Knight, R. (2017) (4/e). Physics for Scientists and Engineers (with Modern Physics). San Francisco: Pearson Addison Wesley.* We will refer to this and use activities from the excellent accompanying student workbook. These are also highly recommended research-based curricula, and we will be working with selections from these. There are both algebra and calculus based versions of the Knight curricula, which are also used in other department graduate and undergraduate courses.

We will also be using readings supplied in-class, notably from the *American Journal of Physics (AJP)* and *The Physics Teacher (TPT)*.

**Course Rationale (as approved by BSC Senate):**

This course is specifically designed and tailored to meet NYSED requirements for middle and high school teachers seeking PHY content credit for Physics teacher certification while meeting requirements for SUNY and NYSED approved M.S.Ed. (Physics) programs at SUNY Buffalo State, and has been accepted for certification by NYSED since 2002, with major revisions in 2021. The course explores standard Mechanics topical content at the *NYSED Regents Physics* level and beyond, particularly topics from the College Board *Advanced Placement (AP) Physics* and *International Baccalaureate (IB) Physics* curricula.

Student Learning Outcomes. Students will:

1. describe physical models using a variety of representations.

2. document experimental evidence for physical models and principles.

3. generate experimental data to measure mechanics quantities and test physical models.

4. analyze the behavior of objects and systems using physical models, principles, and representations.

5. critique student explanations of physical phenomena.

6. synthesize findings of research-based literature related to the teaching and learning of mechanics.

Specific course content:

*I. Fundamental units and measurement. Unit conversions, SI units*

*II. Kinematics: Point particle model. Position, velocity and acceleration in 1d and 2d
Representations: vectors, motion diagrams & kinematics graphs
Special cases: constant velocity, uniform acceleration, uniform circular motion & rotational motion*

*III. Forces: Newton’s Laws, Hooke’s Law and Simple Harmonic Motion, Universal gravitation and Kepler’s Laws, Contact forces (normal, friction, tension, Hooke’s law), Static and Dynamic Equilibrium*

*IV. Conservation laws: Systems, Momentum, Energy and energy transformations (work and power), Angular momentum & Conservation principles and applications*

*V. Physics education research in mechanics: Role of reflective practice and self-monitoring learning (Notebooks, journals, logs), Current research findings: Common naive conceptions of student, Identifying powerful ideas central to these topics, Role of technology in teaching mechanics, Examining innovative teaching strategies in mechanics*

*VI. Mathematical tools and representations (integrated into course content: Vectors, dot products, Algebra, Equations, systems of equations (rarely), 2-d graphs, slopes, and intercepts & Calculus: Derivatives and Integrals of functions of one variable*

**Course Structure:**

This course is not structured as a traditional lecture course; it is much more intense (15 days of 8 hour classes) with considerable and unusual responsibility for learning placed upon the student. We will be demonstrating the kind of reformed instruction that physics education research has shown to be responsible for significantly improved student conceptual learning. You will typically work through selected activities learning and re-learning physics content by alternating between the roles of teacher and student. You will have daily homework, and must plan for weekly learning commentaries, a final project and a final exam. Instructors and facilities will be made available in evenings to supplement regular classroom instruction (optional attendance), and the center of most days is open for student cooperative work and instructor consultation.

**Required Materials:**

You will have access to a modern internet-connected computer and word-processor for assignments on BSC campus, though you may choose to complete some of these homework assignments offsite. You must also have access to a modern word processor to complete your pre-arrival assignment. All assignments must be word-processed, and available in a readable format (as either .doc, .pdf, .rtf or .htm / .html files). Keep personal back-up copies of your work on your own machines and disks for your own safety. You are strongly urged to have an email account accessible from BSC computers (BSC will supply for-credit registered students with another such account). You must also supply a scientific calculator (we actually advise using the free PC Calc Lite app on a smartphone), a mechanical pencil, a pen, paper, graph paper, a ruler and a protractor. Students should acquire and familiarize themselves with .PDF document generator for their smartphone like CamScanner etc. The free watermarked versions are more than sufficient.

You will be provided with a three-ring binder, copies of most course materials, including paper and electronic copies of the *Modeling Physics* curriculum for teaching Mechanics. You will also be provided with electronic access to almost all course related materials including student-created artifacts, some limited amount of physics teaching apparatus, and one dozen whiteboards.

**Schedule:**

The regularly- and frequently-updated course schedule is available from the course webpage. Due to the intense scheduling of this course and SUNY regulations, student absences that result in any student not completing a minimum of 90 hours of documented contact instruction and 270 hours of documented supplementary activity *must* result in a grade of F, W or I for PHY620.

**Assessment of Outcomes and Grades:**

Below is the guaranteed grading scale. We reserve the right to lower grade cutoffs but will not raise them.

 ≥ 90% A

 ≥ 80% B

 ≥ 70% C

 ≥ 60% D

Course assignments will be assessed and weighted as follows.

|  |  |  |
| --- | --- | --- |
| **Activity** | **Grade** | **Due** |
| Pre-Arrival Assignment | 4% | Day 1 of class |
| Reading and Modeling HW, pre-post tests | 40% | schedule |
| Daily Journal | 4% | daily |
| 3 Reflective Physics Commentaries | 12% | Fri d5, 10 & 15 |
| Week 4&5 Online Activities (RL, quizzes) | 10% | d16-24 |
| Final video physics content project | 15% | Friday d25 |
| Final Physics Content online exam | 10% | Thurs d24  |
| **Total** | **100%** |  |

**PreArrival Assignment (4%):**

A short essay involving reflection on your physics knowledge and background, setting personal and course learning goals *available from the course homepage. It is due on the first day of the course.*

**Reading Homework, Reading Logs, Modeling Homework and Pre/Post testing (40%):**

In accord with agreements with the National Science Foundation, on the first and second last days of the course a battery of standardized conceptual and attitudinal instruments will be completed by all students to assess the impact of PHY620. Students will receive credit for completeness and effort upon these instruments. Details for each assignment will be made available upon the course webpage as each is assigned.

**Attendance and the Daily Journal (4%):**

No more than one entry per page. Not to be written in or during class. Put your name prominently on the cover, and do not put your name in your entries. Can be checked on any date during the regular course and will be checked at the end of the course during the final exam. Use your daily journal to prepare your physics learning commentaries.
1) Start with the date.
2) Summary list of physics activities from that day’s class.
3) What physics content did I learn? Please explain your reasoning. Include sketches, figures, diagrams, equations, graphs and other multiple representations as appropriate and sufficient.
4) What questions do I have to guide my physics thinking? If you are absent: Indicate date as ABSENT, list steps taken to make up the activity, and address the entry elements as best possible.

 This diary will be used to generate your physics learning commentaries and hardcopy versions will be reviewed during and at the end of the course.

**Physics Learning Commentaries (3 x 4%):**

Each week a physics learning commentary (LC) will be due Fridays d5, d10 and d15 at 8:00am. Physics LCs are brief one to three page formal essays written after completing and reflecting upon each week's effort. A learning commentary is a story describing at length the evolution of your thoughts on ONE SINGLE PHYSICS IDEA of your own choice. You will describe your initial thoughts, activities, discussions that change or confirm how you think with examples and your final scientific thoughts on a single physics concept. Learning commentaries are word-processed and you will hand in paper copy and a second copy either on disk or as an email attachment. Write your learning commentary starting from your diary, notes and classroom materials. Learning commentaries are graded based upon the quality and quantity of your comments and examples, together with how you support claims for your final scientific ideas with specific data taken from classroom observations and activities. In particular, we will be looking for:

- a description of *your initial scientific ideas* regarding your chosen physics concept based upon your *previous life experiences*, together with a description of your *supporting evidence* for your conceptual state regarding this concept:

- a substantive discussion of *how various class discussions and activities promoted chang*e in your understanding of this physics concept, giving *specific examples as supporting evidence*; and

- a brief description of *your final physics ideas and insights* regarding your chosen physics concept.

A Physics LC can be written with as few as three paragraphs, fewer than five is strongly preferred.

**Week 4&5 Online Activities (RL, quizzes) d16-24 (15%):**

As part of an NYSED-mandated requirement for 270 hours of documented supplementary work outside the classroom, we will conduct synchronous and asynchronous activities days d16-23 of class. These will include guided readings and videos in rotational mechanics, gravitation, materials and oscillations and waves documented by graded logs, and some online quizzes. Some of this work will be topically negotiable by the individual and ore details will be forthcoming.

**Final Video Project (15%):**

PHY620 will host a video presentation session at the end of the course where students will cooperatively present video content on E&M to all course participants. Details on this assignment will be made available in class. You may view previous and similar projects at [www.youtube.com/user/DanMacVids](http://www.youtube.com/user/DanMacVids) .

**Final Content Online Exam (10%):**

## Mechanics content will be evaluated via a one hour content exam given at the end of the course. This exam will address physics content treated during the course, including those typical of NYSED *Regents' Physics* Exams and the NYSTCE *Physics Content Specialty Test (CST)* amongst others. Additional details will be forthcoming.

**Makeup assignments:**

There will be one make-up homework assignment to substitute only for homework missed due to legitimate absence. Total absences must not drop below 90 documented contact classroom hours and 270 documented supplemental activity hours for any for-credit participant in PHY620. There are NO other makeup arrangements. Late homework will be accepted *only* at the discretion of the instructor, typically for half-credit. Generally, no late assignment will be accepted unless a request is made *before* the assignment is due. The make-up homework assignment will only be accepted for institutional excuses or illness, by prior approval from the instructor.

**Statement on plagiarism, cheating and professionalism:**

This is a graduate course for professional educators, and we have absolutely no patience with cheating. Anyone caught cheating may receive a failing grade in the course. Working with other people on homework and activities is not considered cheating, and is in fact encouraged, though your submitted work should reflect your own interpretations and language.

The highest professional conduct is expected of course participants, and unprofessional behavior including repeated tardiness will not be tolerated. For your guidance, a list of teacher dispositions required of Buffalo State students will be made available to you.