**SUNY BUFFALO STATE UNIVERSITY**

**Department of Physics Course Syllabus**

**PHY 622: Electricity & Magnetism for HS Teachers  
Summer 2023 (VS CRN# 1501); BSC Summer Physics Academy**

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

[macisadl@buffalostate.edu](mailto:macisadl@buffalostate.edu) (***email is preferred*** or leave voicemail) Cell: (716) 909-2233 (vm)

Mr. Dave Doty [dotydr@hotmail.com](mailto:dotydr@hotmail.com) (716) 868-4475

Mr. Craig Uhrich [cuhrich@depew.wnyric.org](mailto:cuhrich@depew.wnyric.org) (716) 239-2378

Dr. David Abbott abbottds@buffalostate.edu (716) 878-5201 (O)

Mr. Brad Gearhart [fizz6guy@gmail.com](mailto:fizz6guy@gmail.com)

**Emergencies/Admin:** MacIsaac is carrying a cell phone (716) 909 – 2233 (24h) for the duration of PHY622.   
The Physics Department Phone is (716) 878-6726

**Course Web Pages:** [http://PhysicsEd.BuffaloState.Edu/courses/23/summer/PHY622/](http://physicsed.buffalostate.edu/courses/23/summer/PHY622/) (public); and google dox pages (links provided individually).

**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 MTWRF 10-28 July 2023 (three weeks in person) followed by 31 July-11 Aug 2023 (online most asynchronous with 5 synchronous sessions schedule TBD) during BSC Variable Summer (VS) Session, with possible voluntary evening events. On campus housing can be arranged if desired.

**Pre-requisites:**

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

- Permission of the instructor.

**Textbooks:**

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 modeling curriculum is one of many owned by the AMTA, and *provided by license* *only* to AMTA members, so you must join the AMTA. Many PHY622 students are classified by the AMTA as new workshop attendees, sometimes eligible for reduced cost AMTA membership. Regular membership prices vary but is currently $75/year for regular members. See <https://www.modelinginstruction.org/> look for membership, AMTA considers PHY622 as a modeling course, and yes, they accept credit cards. PHY622 students who are members of AMTA will receive printed and electronic copies of PHY622 related Modeling Curricula files, guides and keys both as PDF and local-teacher-modifiable word documents for classroom reproduction and use. The AMTA website also provides access to blogs, updates versions of materials and extensive listserv archives and active groups discussing individual modeling activities and curricula.

The following texts are all important reference books in the library of any professional physics teacher, and we encourage you to purchase a paper copy and keep it on your work reference shelf, mark it up etc. Having said that we will have a limited number of copies of these texts in the course classroom you can use live before or after class, on breaks and at lunchtime etc. All can be (at least temporarily) electronically accessed via something called the Internet Archive <http://archive.org> Again, if you are serious about teaching this material, you should consider investing in a used physical copy.

2. The second required 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 in the bookstore and at online booksellers ***(we will try to locate a discount code for you if you want to buy)***. *The Arons text is required for PHY500, PHY620 and PHY622, and is supplementary to PHY518 and PHY520 at Buffalo State College, copies are readily found around the department for course use.*

3. An essential reference work is: *Chabay, R. & Sherwood, B (2015) (4/e). Matter & Interactions Vol II: Electric and Magnetic Interactions. NY: Wiley.* This is an outstanding PER-based reform curriculum featuring use of atomic models to teach EM phenomena, though it is expensive of you don’t plan an online purchase, (about $20 used and earlier used editions may also be used). This is one of the best resources for a physics educators’ professional library. You will have several readings from this in PHY622, but several students may wish to share a single purchased text and some copies are also found around the department. This text comes in two volumes and you need only the second <https://www.amazon.com/Matter-Interactions-II-Electric-Magnetic/dp/1118914503>

4. A final suggested 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**. Another of the best resources for a physics educators’ professional library. There are both algebra and calculus based versions of the Knight curricula, which are also used in PHY518, 520 and 525 and several department undergraduate courses.

We will also be using readings supplied in-class, notably from the *American Journal of Physics (AJP)* and *The Physics Teacher (TPT)*. All readings should be available in class. Limited numbers of copies of textbooks 2-4 and all readings are available for use in the SAMC building if so desired.

Student Learning Outcomes (NYSED approved; revised 2021).  Students will:

1. describe physical models predicting electrical and magnetic phenomena using a variety of representations.

2. evaluate experimental evidence for physical models about electrical and magnetic phenomena.

3. apply physical models, representations, and principles to practical situations.

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

5. evaluate the quality of simple direct measurements of physical quantities and the uncertainty in experimental results.

6. critique student explanations of physical phenomena.

7. synthesize findings of research-based literature related to the teaching and learning of physics.

Specific course content:

*I. Static electricity*

*A. Microscopic model of charge*

*1. Common static electricity phenomena, including conductors, insulators & polarization*

*2. Simple atomic model*

*3. Coulomb’s law for point and symmetric objects*

*4. Superposition*

*5. Charge conservation*

*B. Electric field and electric potential difference*

*1. Test charge vs. Field charge*

*2. Analogy with gravitational field*

*3. Representations: potential plots, equipotentials, electric field diagrams*

*4. Relationship between field and potential; Gauss’ Law*

*5. Capacitance and dielectrics*

*II. Direct current electricity*

*A. Electrical current and resistance. Drude Model and surface charge.*

*B. Charge conservation (junction rule)*

*C. Properties of electric potential (voltage loop rule)*

*D. Circuits involving batteries, bulbs, resistors and capacitors*

III. Magnetism and electromagnetic interactions

A. Interactions among magnets, ferromagnetic materials and diamagnetic materials

B. Domain model

C. Magnetic field

1. Definition, measurement, representations

2. Electric current as source (Biot-Savart’s Law)

3. Forces on currents in magnetic fields (Ampère’s Law)

D. Electromagnetic induction (Faraday’s & Lenz’ Laws)

E. Alternating current circuits

F. Maxwell’s Equations

IV. Physics education research in electricity and magnetism

A. Role of reflective practice and self-monitoring learning (Notebooks, journals, logs)

B. Current research findings

1. Common naive conceptions of students

2. Identifying powerful ideas central to these topics

C. Role of technology in teaching electricity and magnetism

D. Examining innovative teaching strategies in E&M

**Course Structure:**

This course is not structured as a traditional lecture course; it is much more intense (15 days of 8 hour classes plus another 10 days online instruction) 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 sometime besides lunch will be 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 PHY622.

**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 | 35% | schedule |
| Attendance and Daily Journal | 4% | daily |
| 3 Reflective Physics Learning Commentaries | 12% | Fri Day 5,10,15 |
| Week 4 and 5 Online Activities (RL+Quizzes) | 20% | Days 16-24 |
| Final video project | 15% | Friday Day 25 |
| Final Physics Content online exam | 10% | Thurs Day 24 |
| **Total** | **100%** |  |

**PreArrival Assignment (4%):**

A short essay involving reflection on physics pedagogy, 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 conceptual and attitudinal instruments will be completed by all students to assess the impact of PHY622. Students will receive credit for completeness and effort upon these instruments. Details for each homework 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. 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.

6

**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%):**

PHY622 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 100 contact classroom hours for any for-credit participant in PHY622. 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 must reflect your own interpretations and your personal language (not a verbatim copy of others). 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 NYSD professional teacher dispositions required of Buffalo State students will be made available to you.

**Reading** **Homework Assignments RHW1-6. (You must also prepare a Reading Log – form is online):**

RHW1: Arons Ch6

*Arons, A.B. (1990). Teaching Introductory Physics. NY: Wiley. Ch6 Static Electricity. P167-187.*

Write a 2-3 page reflective essay discussing how any one of the author’s ideas from this reading can be interpreted

in light of your own experiences teaching and learning physics. Be prepared to discuss these in the course morning briefing session, and if possible relate the reading to experience from this course.

RHW2: Chabay & Sherwood (2/e) Ch14 sections 14.4, 14.7

Read Chapter 14 of C&S, and prepare a Reading Log on Sections 14.4: ***Polarization of Conductors and Insulators*** and 14.7: ***Sparks in Air****.* Check the section content titles -- in the third edition of C&S these are numbered differently as sections 15.3-7 and 21.10. Be prepared to discuss these in the course morning briefing session, and if possible relate the reading to experience from this course.

RHW3: Arons Ch7

*Arons, A.B. (1990). Teaching Introductory Physics. NY: Wiley. Ch7 Current Electricity. P188-218.*

Write a 2-3 page reflective essay discussing how any one of the author’s ideas from this reading can be interpreted in light of your own experiences teaching and learning physics. Be prepared to discuss these in the course morning briefing session, and if possible relate the reading to experience from this course.

RHW4: Saeli & MacIsaac

*Saeli, S. & MacIsaac, D.L. (2007). Using gravitational analogies to introduce elementary electrical field theory concepts. The Physics Teacher, 45(2), 104-108.*

Write a 2-3 page reflective essay discussing how one of the author’s ideas from this reading can be interpreted in light of your own experiences teaching and learning physics. Discuss how the manuscript could be clarified for typical HS teachers. Be prepared to discuss these in the course morning briefing session, and if possible relate the reading to experience from this course. Note this paper was written from PHY622 course experiences.

RHW5: Arons Ch8

*Arons, A.B. (1990). Teaching Introductory Physics. NY: Wiley. Ch8: Electromagnetism. P167-187.*

Write a 2-3 page reflective essay discussing how any one of the author’s ideas from this reading can be interpreted in light of your own experiences teaching and learning physics. Be prepared to discuss these in the course morning briefing session, and if possible relate the reading to experience from this course.

RHW6: Chabay & Sherwood (2/e) Ch18 sections 18.1-10

Read Chapter 18 of C&S, and prepare a Reading Log on Sections 18.1-18.10 **(Chapter 19 in the third edition)** *Microscopic View of Electric Circuits*, focusing on the question of ***how and why electrons move within wires.*** Be prepared to discuss these in the course morning briefing session, and if possible relate the reading to experience from this course.

All RHWs are to be completed as word-processed files saved with names like RHW1YOURLASTNAME.doc and submitted by email attachment to the relevant instructor, as well as by a hardcopy print out turned in at 8am the due day. Include your full name, the date and title of the assignment at the start of each paper. Include an APA reference and page numbers when appropriate.

*The separate RL forms for the C&S text readings are prepared on paper by hand, then CamScanned and turned in BOTH on paper and via CamScanner generated (or similar) .PDF electronic file.*