SUNY EMPIRE STATE COLLEGE LEARNING CONTRACT – Mentor: Fernand Brunschwig
TOPIC OF STUDY: Modeling Instruction in Science – Physics (Electricity and Magnetism), 3 credits, graduate level, not liberal arts and science.

LEARNING ACTIVITIES:
Students will be expected to be either experienced science teachers or involved in a teacher preparation program. Students are expected to have attended either the Mechanics Modeling Workshop or the Modeling Instruction Workshop in Chemistry before taking the E&M workshop. Students will attend 15 full-day sessions of the Microscopic Electricity and Magnetism Modeling Workshop. The workshop is organized by PhysicsTeachersNYC, affiliated with the American Modeling Teachers Association (AMTA). The workshop will follow the workshop outline and use the materials developed and published by the AMTA and its predecessor, the Modeling Instruction Program, over the past 20 years. Resources include the *Modeling Instruction Manual 2013 in Electricity and Magnetism*, which will be provided to participants in both print and digital form.

In this course teachers will work through coherent model-centered materials for high school electricity and magnetism from a microscopic perspective to develop a deep understanding of content and how to teach it effectively. **The focus is on first-year physics courses that incorporate algebra and trigonometry.** To develop familiarity with the materials necessary to fully implement them in the classroom, we find that teachers must work through the activities, discussions and worksheets, alternating between student and teacher modes, much as they did in the 1st Modeling Workshop in Mechanics. Each of the four units in the E & M course manual includes an extensive Teacher Notes section. Throughout the course, teachers are asked to reflect on their practice and how they might apply the techniques they have learned in the course to their own classes.

Description of each unit of the course:

Unit 1: **Charge and field.** We begin with the study of electric charge and the different methods of charging matter electrically. Next we determine the relationships for the force between two charged particles. We finish by defining the electric field, investigating the electric field produced by charged particles and collections of charged particles, and determining the force on a charged object by a field.

Unit 2: **Potential.** In this unit we delve into the concepts of electrical energy and electric potential. We make topographic maps to help develop an understanding of equipotential lines. We will learn whether energy is transferred into or out of an electric field when a charged particle is moved in the field, along with whether or not the object has been moved through a change in potential (potential difference).

Unit 3: **Circuits.** The circuit unit begins by developing the surface charge model as the causal agent for steady state circuits. We will continue to use the concept of the electric field but now we will relate it to circuit behavior. We then experimentally determine the relationship of potential difference and current for a circuit after which we move into the investigation of circuits with series and parallel resistors.

Unit 4: **Magnetism.** The magnetism unit begins with an investigation of the magnetic field around a current bearing wire after which we look at the fields of permanent magnets. We then delve into the magnetic force on a charged particle and the on a current bearing wire. A motor will be made taking advantage of this force. We will study the behavior of charged particles in both magnetic and electric fields. We finish the unit with the study of electromagnetic induction. Faraday's Law is studied both conceptually and mathematically.

STUDENT LEARNING GOALS: At successful completion of this course, students will have

- improved their instructional pedagogy by incorporating the modeling cycle, inquiry methods, critical and creative thinking, cooperative learning, and effective use of classroom technology,
- deepened their understanding of content in microscopic electricity and magnetism,
- experienced and practiced instructional strategies of model-centered discourse, Socratic questioning/whiteboarding, use of standardized evaluation instruments, coherent content organization,
- strengthened coordination between mathematics and physics,
- increased their skill in all eight scientific practices recommended by the National Research Council in "A Framework for K-12 Science Education." Models and theories are the purpose and the outcomes of scientific practices. They are the tools for engineering design and problem solving. As such, modeling guides all other practices.

METHODS AND CRITERIA FOR EVALUATION:

A. Attendance: You are expected to attend all days of this course. If you miss two classes (13 contact hours), your maximum grade will be a B; if 3, you can earn no higher than a C. Please be on time and ready to go! Report any expected absences to the instructor as soon as possible.

B. Assignments and grading policy:

Students will contract for a letter grade on the second class day. Contracting for a letter grade is not a guaranteed grade. Work must be completed at SUNY Empire State College graduate standards and meet all class requirements.

To be considered for a letter grade of "C", you will be expected to do the following:

- Keep a course notebook. Teachers have found this notebook to be a valuable resource as they use the curricular materials in their own classes. Consequently you are expected to record notes pertaining to **everything** that we do. When you return home and do the labs and activities you are not going to remember many of the details that came out in discussions and activities. Place them in your notebook as you work. When we perform labs you are to record notes from the pre-lab discussion, record and evaluate data (include any graphs you make) and summarize the findings of the "class" in your lab notebook. (Summarize means write the relationship, the equation if applicable, the general equation and what the slope represents). You are expected to write down notes that will help you when you doing the lab with your students. Some teachers benefit by writing down good questions asked during whiteboarding, but that is up to you. You should also take notes on demonstrations and the concept they are meant to illustrate. (50%)
- Work out all problems and questions on the worksheets and insert them into your 3-ring binder. (10%)
- Participate actively and thoughtfully in lab whiteboarding sessions, discussion of readings, activities, and problem-solving whiteboarding. (10%)
- Read excerpts from the *Matter and Interactions* textbook by Ruth Chabay and Bruce Sherwood and physics education research articles. For each reading you will be expected to write a one-half to one-page *reaction* (not a synopsis) in which you offer your views about the ideas discussed in the reading assignment. (10%)
- For each unit, record your reflections on the activities of your team as you work through the materials. (10%)

To be considered for a "B" grade, you must do all of the above plus two additional assignments. One is a two-page (minimum) typed reflection paper describing one of the following: how the Modeling E&M instruction differs from your current practice and what changes you plan to incorporate or the issues with which you will have to deal in order to implement the Modeling Method in your classroom. The other is a formal lab write up for the Ohm's Law investigation.

To be considered for an “A” grade, you must do all of the above and complete two additional assignments. They may be chosen from two problem sets, or writing VPython programs. The problem sets are of the level of E&M problems found in an honors or AP-B course. (Set 1 is due at the end of the second week of class and set 2 is due on next-to-last course day.)

C. Grading scale:

	93-100 A	90-92.9 A-	
	87-89.9 B+	83-86.9 B	80-82.9 B-
	77-79.9 C+	73-76.9 C	70-72.9 C-