**SYLLABUS**

**Course Number: REAL 694 Z21**

**Course Title: Summer Secondary Physics Institute – Mechanics**

###### 2 Semester Hours Graduate Credit

**1. Catalog Description:**

This course offers physics content and laboratory experiments in Newtonian mechanics for high school physics teachers. This course is primarily intended for new teachers and teachers teaching out of field.

**2. Course Overview\Course Teaching Methods:**

This course is one of five on physics content and classroom experiments and techniques for high school teachers. (No prerequisite is required.) This course will cover content in the area of Newtonian mechanics at an appropriate level for participants and sound pedagogy modeled. Time will be included for reflection and discussion of best pedagogical practices. This course will be especially useful for new teachers and teachers teaching out of their major field.

Course Teaching Methods:

This course is a blend of discussion and hands-on, laboratory-based experiences. Individuals participating in the class learn how to plan and conduct effective laboratory experiences by actually executing them from the student’s perspective. Master teachers will lead discussion and exploration of Newtonian mechanics and effective pedagogy and laboratory experiences for use in participants’ own classrooms. Laboratory experiments will include work with both traditional equipment and computer-based, data-taking devices. In addition, participants will have an opportunity to learn from Fermilab physicists and tour selected Fermilab sites.

**3. Student Learning Objectives\Illinois Content and Professional Teaching Standards**

As a result of this course, participants will be able to:

* Employ enhanced knowledge and understanding of the concepts of Newtonian mechanics in their planning and teaching.
* Refine their classroom pedagogy and laboratory techniques for teaching Newtonian mechanics in high school.
* Employ both traditional and computer-based laboratory equipment for teaching Newtonian mechanics.

Illinois Professional Teaching Standards Addressed

1. Content Area and Pedagogical Knowledge - The competent teacher has in-depth understanding of content area knowledge that includes central concepts, methods of inquiry, structures of the disciplines, and content area literacy. The teacher creates meaningful learning experiences for each student based upon interactions among content area and pedagogical knowledge, and evidence-based practice.
2. Planning for Differentiated Instruction - The competent teacher plans and designs instruction based on content area knowledge, diverse student characteristics, student performance data, curriculum goals, and the community context. The teacher plans for ongoing student growth and achievement.
3. Learning Environment - The competent teacher structures a safe and healthy learning environment that facilitates cultural and linguistic responsiveness, emotional well-being, self-efficacy, positive social interaction, mutual respect, active engagement, academic risk-taking, self-motivation, and personal goal-setting.
4. Instructional Delivery - The competent teacher differentiates instruction by using a variety of strategies that support critical and creative thinking, problem-solving, and continuous growth and learning. This teacher understands that the classroom is a dynamic environment requiring ongoing modification of instruction to enhance learning for each student.
5. Assessment - The competent teacher understands and uses appropriate formative and summative assessments for determining student needs, monitoring student progress, measuring student growth, and evaluating student outcomes. The teacher makes decisions driven by data about curricular and instructional effectiveness and adjusts practices to meet the needs of each student.
6. Collaborative Relationships - The competent teacher builds and maintains collaborative relationships to foster cognitive, linguistic, physical, and social and emotional development. This teacher works as a team member with professional colleagues, students, parents or guardians, and community members.

*NGSS Science and Engineering Practices Addressed*

1. Asking questions (for science) and defining problems (for engineering)

2. Developing and using models

3. Planning and carrying out investigations

4. Analyzing and interpreting data

5. Using mathematics and computational thinking

6. Constructing explanations (for science) and designing solutions (for engineering)

7. Engaging in argument from evidence

8. Obtaining, evaluating, and communicating information

*NGSS Crosscutting Concepts Addressed*

1. Patterns
2. Cause and Effect
3. Scale, Proportion and Quantity
4. System and System Models
5. Energy and Matter
6. Structure and Function
7. Stability and Change

*NGSS Disciplinary Core Ideas Addressed*

* **PS2.A** Forces and Motion
* **PS2.B** Types of Interactions
* **PS3.A** Definitions of Energy
* **PS3.B** Conservation of Energy and Energy Transfer
* **PS3.C** Relationship between energy and forces
* **ETS1.A** Defining and Delimiting Engineering Problems
* **ETS1.B** Developing Possible Solutions
* **ETS1.C** Optimizing the Design Solution

Standards for Professional Learning [See Appendix I for expanded justification.]

Participants in this course will develop their understanding of learning communities, leadership, resources, data, learning design, implementation, and outcomes as they pertain to physics instruction.

APPENDIX I

**Standards for Professional Learning**

Standards for Professional Learning is the third iteration of standards outlining the characteristics of professional learning that lead to effective teaching practices, supportive leadership, and improved student results. Learning Forward, with the contribution of 40 professional associations and education organizations, developed the Standards for Professional Learning. The standards make explicit that the purpose of professional learning is for educators to develop the knowledge, skills, practices, and dispositions they need to help students perform at higher levels. The standards are not a prescription for how education leaders and public officials should address all the challenges related to improving the performance of educators and their students. Instead, the standards focus only on professional learning.

Standards for Professional Learning outline the characteristics of professional learning that leads to effective teaching practices, supportive leadership, and improved student results. Through the Standards for Professional Learning, Learning Forward leads the field in understanding what links professional learning to improved student achievement.

This course will address the seven standards within the Professional Learning Outcomes so that participants will gain the most benefit from this professional development. The following are the seven expanded outcomes that will be covered in this course:

**Learning Communities**

A cycle of continuous improvement requires internalized methods of improving knowledge and skills. Through both discussion and activity, participants will begin to develop methods to continually improve physics teaching skills beyond this course. Discussion of the seven step cycle of continuous improvement, as well as connecting to both digital and traditional physics teaching communities will allow participants to continue to expand teaching knowledge and skills. This course will directly increase participants’ capacity for collaboration.

**Leadership**

Effective teachers should be able to advocate for continued improvement in a variety of settings. Through engaging in discussion, participants in this course will learn how to become both formal and informal leaders in advocating for physics instruction in school districts, from classroom to district level improvement.

**Resources**

Effective teaching requires management of resources. This course will provide many alternate solutions that allow participants to learn to manage resources such as time, material, and technology. Different methods of managing resources will be presented, as well as sharing of effective digital teaching materials. Some physical resources, such as lab materials, will be created during the course that will improve physics instruction. This course will also teach skills necessary to create lab resources.

**Data**

Accurate data interpretation allows for instructors to make better informed classroom decisions. Participants will discuss different methods of gathering and interpreting classroom data, and then design classroom methods that will accurately measure both teacher effectiveness, and student achievement.

**Learning Designs**

Integrating models of student learning is crucial in creating effective instruction. Through example in this course, course facilitators will provide different designs of learning structure and facilitate participant discussion on their merit. Participants will continue these ideas by designing their own classroom activity that reflects an understanding of both student and instructor needs, and promotes active engagement.

**Implementation**

The implementation of instruction is a main focus of this course. Participants will experience a variety of methods of implementing physics instruction. These methods will include class experiences, discussion, lab activities and homework assignments that have been tested and found to be effective in the classroom. Participants in this course will also provide a demonstration of a physics concept before the end of the course to provide evidence for improvement in Implementation skills.

**Outcomes**

By providing clear and appropriate outcomes for the classroom, instructors are able to guide students in a more effective manner. Participants in this course will be given example learning objectives for the physics classroom, as well as designing learning objectives to be utilized their own classroom. Methods of conveying standards to students will also be a point of discussion. Through these methods, participants in this course should be able to create and implement learning objectives in their own classroom.

**4. Units of Work\Text and Required Reading:**

#### Session One - Morning

* Welcome/Introduction to the Course
* Kinematics
* Motion Lab: Speed and Acceleration
* Demonstration: Instantaneous Motion

#### Session One - Afternoon

* Physicist Talk
* Reference Frame
* Historical Perspectives

#### Session Two - Morning

* Vectors
* Conservation of Momentum
* Highway Vectors and Orienteering
* Participant Sharing

#### Session Two - Afternoon

* Experimental Area Tour
* Top Quark Activity

#### Session Three - Morning

* Demo on Projectile Motion
* Projectile Motion Graphing in One, Two, and Three Dimensions
* Force Activity: Catching Balls and Eggs

#### Session Three - Afternoon

* Accelerator Division Tour

#### Session Four - Morning

* Momentum
* Angular Momentum
* Build your own lab.

#### Session Four - Afternoon

* Impulse and Momentum
* Participant Sharing
* Discussion with a Physicist

#### Session Five - Morning

* Work and Energy
* Kinetic vs. Potential Energy Demo
* Energy Tracks
* Physicist Presentation on Energy Conservation

#### Session Five - Afternoon

* Wrap-up/Review
* Evaluation

Text and Required Reading**:**

There is no required textbook for this course, though participants are encouraged to bring the textbook from which they will be teaching. Participants construct their own reference material through carefully recording their experiments, observations, questions, and thoughts. Participants are encouraged to refer to the resources in the bibliography for additional information and ideas.

1. **Class Assignments:**

Participants who successfully complete the course will actively engage in all aspects of the course **and** complete an implementation plan for using at least one laboratory experiment from the course in their classroom. This plan, which will serve as the final examination for the course is due to the instructor no later than **one week** after the last course session and must include:

* A brief description of the material the participant intends to use to lead up to the laboratory experiment as well as what material will follow after completion of the experiment.
* What equipment the participant intends to use and the plan to distribute it and have students work with it (e.g., in pairs or groups of three or four; all at once or in stations, etc.).
* An approximate timeline and outline for the experiment in your classroom.
* Expectations for student lab reports
* Anything extra planned such as:
* Student sharing and peer review of results
* Student-led extensions of the experiment
* Any other ideas or considerations unique to your school or teaching situation

Please understand that this implementation plan is not designed to be just a requirement to com­plete. It is to assist participants in carefully planning and effectively implementing this experiment.

**6. Evaluation and Grading Procedures:**

1. Laboratory Experiment Implementation Plan (**30 points possible**):

1. Curricular lead-up to experiment is clearly described. **10 points**

2. Connections to the larger topic, as well as to preceding and

subsequent topics, have been thoughtfully made. **10 points**

3. Outline of experiment is complete, and timeline is realistic. **5 points**

4. Expectations for lab reports and extra activities have been

incorporated into the unit plan. **5 points**

1. Performance Activities (**40 points possible**):

Participants will be required to:

1. Carry out a laboratory activity involving two-dimensional motion. **8 points**

2. Use vector mathematics to reach a series of objectives. **8 points**

3. Build a working projectile launcher for use in their classroom. **8 points**

4. Construct a laboratory apparatus for momentum. **8 points**

5. Create working “Energy Tracks” for classroom use. **8 points**

1. Class Participation **(30 points possible):**

Participants will be expected to take active roles in both full-class and small-group discussion:

* + - * **30-25 points**: Is always prompt and is a regular attendee. Always participates actively in both small- and large-group settings. Always willing to share ideas and reflections on activities. Listens respectfully when others talk. Communicates results and shares data in a clear and concise fashion. When appropriate, offers constructive criticism of peers’ contributions to class discussions.
      * **24-20 points**: Is a prompt, regular attendee. Participates actively in both small- and large-group settings. Willing to share ideas and reflections on activities. Listens when others talk. Communicates results and shares data. Offers constructive criticism of peers’ contributions to class discussions.
      * **19-15 points**: Is a prompt, regular attendee. Participates in small-group settings. Shares ideas and reflections on activities when called upon. Listens when others talk. Makes an effort to communicate results and share data. Makes an effort to offer constructive criticism of peers’ contributions to class discussions.
      * **15-0 points**: Is an irregular or frequently tardy attendee. Rarely participates in either small- or large-group settings. Does not listen when others talk. Offers minimal or inappropriate comments on peers’ contributions to class discussions.

**Grading Scale**

**A = 92-100 points**

**B = 84-91 points**

**C= 75-83 points**

**F = 0-74 points**

University of St. Francis

College of Education

Graduate Grading System

The graduate grading system was reviewed by Deans’ Council and forwarded to the Academic Standards Committee for deliberations. This was approved by the Academic Standards Committee as of 5 May 1992 for presentation to the Faculty Senate on 12 May 1992.

A (4 quality points per course unit) - Excellent. Denotes work that is consistently at the highest level of achievement in a graduate college or university course.

B (3 quality points per course unit) - Good. Denotes work that consistently meets the high level of college or university standards for academic performance in a graduate college or university course.

C (2 quality points per course unit) - The lowest passing grade. Denotes work that does not meet in all respects college or university standards for academic performance in a graduate college or university course.

F (0 quality points per course unit) - Failure. Denotes work that fails to meet graduate college or uni­versity standards for academic performance in a course.

**7. Attendance Policy:**

Participants are required to attend all course sessions and to actively engage in class discussions, small group activities, experimental and experiential group exercises and projects.

**8. Academic Honesty and Integrity:**

Students are expected to maintain academic honesty and integrity as students at the University of St. Francis by doing their own work to the best of their ability. Academic dishonesty (cheating, fabrication, plagiarism, etc.) will result in the student receiving a zero for that test, assignment or paper.

**9. Final Examination Policy:**

The final examination for the course will be the laboratory implementation plan, described in detail in Section 5 above.

**10. Americans with Disabilities Act:**

In compliance with ADA guidelines, students who have any condition, either permanent or temporary, which might affect their ability to perform in this course, are encouraged to inform the instructor at the beginning of the course. Adaptations of teaching methods, class materials, including text and reading materials or testing may be made as needed to provide for equitable participation.

**11. Bibliography:**

Books:

Ehrlich, Robert, *Turning the World Inside Out and 174 Other Simple Physics Demonstrations*, Princeton University Press, Princeton, NJ, 1990.

Feynman, Richard, *The Character of Physical Law*, The M.I.T. Press, Cambridge, MA, 1965.

Osborne, Roger, and Peter Freyberg, *Learning in Science*, Heinemann, Auckland, New Zealand, 1985.

Serway, Raymond A., and Jerry S. Faughn, *College Physics*, Saunders Golden Sunbrust Series, 1992.

Serway, Raymond A., and Jerry S. Faughn, *Physics*, Holt, Reinhart, and Winston, 2000.

Young, Hugh D., *Physics*, Addison Wesley, 1992.

Learning Forward. (2014). *Standards into practice: External roles. Innovation Configuration maps for Standards for Professional Learning*. Oxford, OH: Author.

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Abdul-Haqq (1997). *Professional development schools: Weighing the evidence.* Thousand Oaks, CA: Corwin Press.

Carroll, T. (2009). The next generation of learning teams. *Phi Delta Kappan, 91*(2), 8-13.

Darling-Hammond, L. & Bransford, J. (Eds.) (2005). *Preparing teachers for a changing world: What teachers should be able to learn and be able to do.* San Francisco, CA: Jossey-Bass.

Darling-Hammond, L. (2006). *Powerful teacher education lessons for exemplary programs.* San Francisco, CA: Jossey-Bass.

DuFour, R. (2011). Work together but only if you want to. *Phi Delta Kappan, 92*(5), 57-61.

Eggen, P. & Kauchak, D. (2004). *Educational psychology: Windows on classrooms.* Columbus, OH: Pearson.

Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement.* New York: Routledge.