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| **SYLLABUS**  **Course Number: REAL-694-Z12**  **Course Title: Summer Secondary Physics Institute – Engineering Applications**  **2 Semester Hours Graduate Credit** |

**1. Catalog Description**

This institute offers physics content and laboratory experiments in engineering applications 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 institute is part of a series on physics content and classroom experiments and techniques for high school teachers. (None is a prerequisite for any other.) Master teachers will lead discussion and exploration of engineering applications and effective pedagogy and laboratory experiences for use in participants’ own classrooms. In addition, participants will have an opportunity to learn from Fermilab engineers and physicists and tour selected Fermilab sites.

**Course Teaching Methods:**

This class is a blend of discussion and hands-on, laboratory-based experiences. Participants will learn how to plan and conduct effective laboratory experiences by actually executing them from the student’s perspective. After completing an experiment, participants will engage in dialog with each other and the instructors regarding the use of the experiment. These discussions will address curriculum connections, potential misconceptions, safety issues, and other topics of participant interest.

**3. Student Learning Objectives\Illinois Content & Teaching Standards Addressed**

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

* Develop and enhance his or her knowledge and understanding of engineering applications for high school physics content.
* Explore and refine classroom pedagogy and laboratory techniques for teaching engineering applications in high school physics.
* Synthesize the knowledge and experiences described above in a way that will allow the student to use engineering applications effectively in their setting.

Illinois Physics Content Area Standards Addressed

1. The competent physics teacher understands the essential knowledge and skills needed to practice physics and understands the broad applicability of its principles to real-world situations.

Illinois Professional Teaching Standards Addressed

2. 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.

4. 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.

5. 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.

Next Generation Science Standards Addressed

1. Science and Engineering Practices

a. Asking questions and defining problems

b. Developing and using models

c. Planning and carrying out investigations

d. Analyzing and interpreting data

e. Using mathematics and computational thinking

f. Constructing explanations and designing solutions

g. Engaging in argument from evidence

h. Obtaining, evaluating, and communicating information

2. Disciplinary Core Ideas

a. PS2.A: Forces and Motion

b. PS2.B: Types of Interactions

c. PS3.A: Definitions of Energy

d. PS3.B: Conservation of Energy and Energy Transfer

3. 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.

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

#### Day One – Morning

* Welcome/Introduction to the Course
* 1-D Motion
* Reaction Time Activity
* Vectors
* Vector Draft

#### Day One – Afternoon

* Discussion with a Physicist
* Projectile Motion Lab

#### Day Two – Morning

* Projectile Motion Demonstrations
* Newton’s Laws and Misconceptions
* Inertial Air Puck Make and Take

#### Day Two – Afternoon

* Tour
* Dynamics Lab
* Analysis of Data

#### Day Three – Morning

* Energy and the Conservation of Energy
* Energy Labs
* Energy Demonstrations

#### Day Three – Afternoon

* Tour
* Paper Roller Coasters

#### Day Four – Morning

* Horsepower Activity
* Conservation of Momentum Lab

#### Day Four – Afternoon

* Discussion with a Physicist
* Newton’s Third Law of Motion
* Momentum Demonstrations

#### Day Five – Morning

* Participant Sharing – Newton’s Laws of Motion Demonstrations
* Impulse Demonstrations and Activities

#### Day Five – Afternoon

* Sharing Resources

**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.

**5. Class Assignments**

Students who successfully complete Engineering Applications will actively participate in all aspects of the workshop **and** complete an implementation plan for using at least one engineering application project from the institute in their classroom. This plan is due to the instructor no later than one week after the conclusion of the workshop and must include the items in 6I. below.

**6. Evaluation and Grading Procedures**

1. **Engineering Applications Implementation Plan (30 points possible):**

1. Curricular lead-up to project 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 project is complete and timeline is realistic. 5 points

4. Expectations for reports and extra activities have been

incorporated into the plan. 5 points

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

Participants will be required to:

1. Use Microsoft Excel to analyze data from experiments. 8 points

2. Complete the “make-and-take” demonstration. 8 points

3. Complete two engineering application construction projects. 16 points

4. Conduct at least one Newton’s Laws of Motion demonstration. 8 points

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

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

* + - * **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.

**The grading scale will be as follows:**

**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

At the end of the course, letter grades are awarded as defined:

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 classes and to engage in class discussions, small group activities, experimental and experiential group exercises and projects.

**8. Academic Honesty and Integrity Statement**

Students are expected to maintain academic honesty and integrity as students of 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**.** The complete academic integrity statement is found in the current graduate catalog.

**9. Final Examination Policy**

In lieu of a final examination, the level of participation and the implementation plan will be evaluated for the determination of a grade.

**10. American Disability Act Compliance**

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**

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.

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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.

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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-analysis relating to achievement.* New York: Routledge.