Physics 447/647 4 credits

Integrating Physical Science with Mathematics and Developing Problem-solving Abilities II

Meeting Times: M 3:30-7:00; out of class time expected to be 6-8 hours/week
Pre-requisite: PHY 245 or PHY 240 or undergraduate BA or BS degree
Instructor: Dr. B. Basista Office: 259 Fawcett Hall Phone: 775-2954
Office Hours: M, T 2-3 pm

This course is required for students pursuing a
1) secondary education certification in Comprehensive Science or Physics
2) BA in Physical Science for licensure
3) M.S.T. in Physics

Course Objectives

Students will:

- develop a depth of physical science content knowledge and pedagogical knowledge
- develop an understanding of how to integrate science and mathematics content knowledge in the classroom while maintaining the integrity and depth of each discipline
- develop oral questioning skills and authentic assessment techniques for fundamental physics and mathematics concepts
- create lesson plans congruent with state and national standards with emphasis on developing student understanding of the processes in science and mathematical reasoning, developing student problem-solving abilities, and addressing student misconceptions of science concepts
- increase understanding of an ability to implement national and state science and mathematics standards
- acquire an understanding and ability to utilize multiple representations
- acquire experience and understanding in the uses of technology in the classroom
- develop an understanding of case study methods to improve classroom teaching
- address pedagogical issues such as attitudes toward science and mathematics, inquiry teaching methods, cooperative learning, authentic and alternative assessment, classroom management, equity, diverse learning styles.

Course Requirements:

Students must take pre- and post-examinations to assess their understanding of science and mathematics content.

Students must perform case studies in the areas of science process skills and measurements; area, volume; mass and balance; density and proportional reasoning; applications of density. The appropriate environment to perform these case studies in will be arranged through discussions with the instructor. The format of the case studies will be arranged with the instructor.

Students must develop at least one lesson plan unit for at least one of the fundamental concepts covered in this course. Each lesson plan will include a clear explanation of the topic of the lesson including references; a clear description of the lesson and experiment for the teacher; student worksheets for the students and student worksheets with expected answers for the teacher; authentic assessment of the lesson. Lessons will emphasize not only conceptual development, but development of primary and integrated process skills, mathematics reasoning skills and problem-solving skills. Lessons will be integrated with level-appropriate mathematics. Each lesson will comply with state and national science standards in that it will be articulated with the unifying themes and processes; be an inquiry/constructivist lesson; relate to real-life applications of the concepts; provide historical and societal perspectives. Graduate students must develop a unit of cohesive lessons, rather than one lesson.

Graduate inservice teacher students must pilot at least a portion of their created unit in their classroom and perform action research to assess the effectiveness of the lesson(s). Documentation of the lesson(s) can include video taping of the lesson in the event that the instructor is not able to observe the lesson.

Undergraduate students will lead-facilitate at least one activity topic in either SM145, PHY 245 or PHY 346.

Weekly group meetings with course faculty for discussion of lesson plans and pedagogical issues effective implementation of the standards in the classroom are required. Literature searches, reading, and reflections of current research in pedagogical issues are required. Weekly meetings will arranged with the course instructor.

Grading:	**Graduate**	**Undergraduate**
1) Case Studies	35%	35%
2) Posttest content score	10%	15%
3) Lesson plans/unit	30%	25%
4) Pilot of lesson plan	10%	10%
5) Weekly meetings	8%	8%
6) Literature searches, readings, reflections	7%	7%

References:

American Association for the Advancement of Science. (1989). *Science for all Americans.* New York: Oxford University Press.

American Association for the Advancement of Science. (1993). *Benchmarks for science literacy.* New York: Oxford University Press.

Arons, A. (1997). *Teaching Introductory Physics.* New York: John Wiley & Sons.

Czerniak, C., Weber, W., Sandmann, A., & Ahern, J. (1999). A literature review of science and mathematics integration. *School Science and Mathematics, 99* (8), 421-430.

Lawson, Anton (1995) *Science Teaching and the Development of Thinking* Belmont, CA: Wadsworth Publishing Co.

McDermott, L.C. (1996). *Physics by Inquiry: Volumes I and II.* New York: John Wiley & Sons.

National Council of Teachers of Mathematics. (1989). *Curriculum and Evaluation Standards for School Mathematics.* Reston, VA: Author.

National Council of Teachers of Mathematics. (1995). *Assessment standards for school mathematics.* Reston, VA: Author.

National Council of Teachers of Mathematics. (2000). *Principles and Standards for School Mathematics.* Reston, VA: Author.

National Research Council. (1996). *National Science Education Standards.* Washington, DC: National Academy Press.

State Board of Education. (1994a). *Model competency-based mathematics program.* Columbus, OH: Author.

Tentative Schedule of Topics

Week **Concepts**----------

1 *Pretest of Science and Mathematics content Knowledge and Pedagogical Content Knowledge*
Science Process Skills Multiple Representations;Mathematical Process
Weekly discussion topic: Case Study Methods

2 *Nature of Light*
Student Misconceptions
Science and Mathematics Standards
Weekly discussion topic: Methods of Integration of Science and Geometry

3 *Reflection and Refraction*
Diagrammatic Techniques
Case Study Updates
Weekly discussion topic: Integration of Science and Mathematics

4 *Waves*
Concrete and Abstract Experiences
Progress check on units/lessons
Weekly discussion topic: Integration of the Sciences: Real World Problems

5 *Electricity*
Science, Technology and Society: Establishing Relevance for students
Performance Assessment Techniques
Weekly discussion topic: Qualitative and Quantitative Reasoning

6 *Magnetism*
Utilization of Technology
Weekly discussion topic: Mathematical Modeling and Science

7 *Sounds*
Action Research Techniques
Weekly discussion topic: Student-designed science projects
Literature review reports due

8 *Applications of Sound*
Progress check on units
Weekly discussion topic: What does the current literature have to say about how students learn science and math? Sharing of literature search and reports.

9 *Current curricular Materials*
Pilot study and action research presentations of lesson plan implementation.

10 *Pilot study and action research presentations of lesson plan implementation*

Final Exam: Posttest of science and mathematics content knowledge and pedagogical knowledge