Texas Prefreshman Engineering Program (TexPREP) II: Engineering Physics and Integrated Algebra

PEIMS Code: N1303753

Abbreviation: TXPRENG2

Grade Level(s): 9-12

Award of Credit: 1.0

Approved Innovative Course

- Districts must have local board approval to implement innovative courses.
- In accordance with Texas Administrative Code (TAC) §74.27, school districts must provide instruction in all essential knowledge and skills identified in this innovative course.
- Innovative courses may only satisfy elective credit toward graduation requirements.
- Please refer to TAC §74.13 for guidance on endorsements.

Course Description:

TexPREP II: Engineering Physics and Integrated Algebra coursework engages students in physics, mathematics, and engineering practices by exploring real-world challenges. TexPREP II integrates core concepts in physics, scientific and engineering practices, and conceptual knowledge to allow students to integrate their academic content knowledge with evidence to generate and internalize scientific principles. Throughout the course students share preconceptions, collect and interpret evidence, generate claims, and develop concepts themselves through evidence-based consensus building. Students experience unique applications and research related to engineering and physics from speakers and university presentations.

Essential Knowledge and Skills:

(a) General Requirements. General requirements. This course is recommended for students grades 9-12. Required prerequisite: Mathematics, Grade 8 or its equivalent. Students shall be awarded one credit for successful completion of this course.

(b) Introduction.

(1) Career and technical education instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.

(2) The Science, Technology, Engineering, and Mathematics (STEM Career Cluster focuses on planning, managing, and providing scientific research and professional and technical services, including laboratory and testing services, and research and development services.

(3) TexPREP II: Engineering Physics and Integrated Algebra coursework engages students in physics, mathematics, and engineering practices by exploring real-world challenges.

TexPREP II integrates core concepts in physics, scientific and engineering practices, and conceptual knowledge to allow students to integrate their academic content knowledge with evidence to generate and internalize scientific principles. Throughout the course students share preconceptions, collect and interpret evidence, generate claims, and develop concepts themselves through evidence-based consensus building. Students experience unique applications and research related to engineering and physics from speakers and university presentations.

(4) Students are encouraged to participate in extended learning experiences such as career and technical organizations and other leadership or extracurricular organizations.

(5) Statements that contain the word “including” reference content that must be mastered, while those containing the phrase “such as” are intended as possible illustrative examples.

(c) Knowledge and Skills.

(1) Employability skills. The student researches and exhibits professional standards and employability skills as required by STEM business and industry. The student is expected to:

(A) establish education and career goals using self-awareness of interests and talents and research of educational and career information;

(B) present written and oral communication in a clear, concise, and effective manner including explaining and justifying actions;

(C) define and demonstrate effective communication and interaction as a member of a group to develop a common goal, contribute questions and concerns to achieve a positive collective outcome; and

(D) research a variety of STEM professions and describe the pathway, including post-secondary education opportunities, that lead to a profession.

(2) STEM process standards. The student distinguishes the influence of science, engineering, and technology on society. The student is expected to:

(A) assess the impact new technologies the field of physics can have on society and the environment, including impacts that were not anticipated;

(B) relate the impact of past and current physics research on scientific thought, engineering practices and society, including contributions of diverse physicists as related to the context; and

(C) evaluate the benefits of a technological system by applying basic knowledge of physics and engineering design practices.

(3) STEM process standards. The student applies STEM principles and reasoning to solve problems. The student is expected to:

(A) develop ideas and document observations and data using an engineering notebook;

(B) explain or justify complexities of a phenomenon by using collaboration and incorporating the ideas of others;

(C) construct well-reasoned arguments to explain phenomena, validate conjectures, or support positions;

(D) support or modify claims with evidence based on the results of scientific inquiry; and

(E) design and conduct experimental investigations and analyze data by applying knowledge of science, mathematics, and engineering.

(4) Engineering physics and integrated algebra. The student explores applied physics emphasizing math and engineering fundamentals to develop, share, critique, argue and revise evidence-based ideas. The student is expected to:

(A) justify physics concepts and models using algebra;

(B) build and apply evidence-based models for concepts related to static electricity including charge transfer, tendency to gain or lose electrons, charge localization, and discharge;

(C) generate and interpret graphs and charts describing different types of motion using real-time technology;

(D) explain energy transfer and conversions using motion graphs and the Law of Conservation of Energy;

(E) describe and analyze the relationship between force and acceleration;

(F) justify the proportional relationship between acceleration and force using models to represent a system and its interactions;

(G) analyze the proportional relationships between kinetic energy, mass, and velocity by applying algebra and functions to represent and solve scientific and engineering problems;

(H) formulate a method to determine acceleration and analyze velocity-time graphs by using appropriate mathematical representations; and

(I) analyze the mathematical relationship between net force, mass, and acceleration by designing and evaluating a system.

Recommended Resources and Materials:

Resources include:

- Volunteer guest speakers with STEM backgrounds
- Materials for prototypes, such as regular household items, alligator clips, binder clips, copy paper, rubber bands, straws, painters' tape, small boxes, foil, cellophane, pipe cleaners etc.
- Science, and/or engineering labs
- Lab supplies and equipment such as Vernier LabQuest Mini, dynamics carts and track system, lasers, beakers, graduated cylinder, radiometer, goggles, sensors, spectrum tube power supply, etc.
- Engineering notebook

"Simulations", University of Colorado Boulder: PhET Interactive Simulations, accessed February 27, 2023, http://www.phet.colorado.edu/en/simulations/browse.

"Chapters", PEER Physics, accessed February 28, 2023, http://www.peerphysics.org/transforming-classrooms/.

"Homepage", the Physics Classroom, accessed February 28, 2023, http://physicsclassroom.com

"Browse k-12 STEM Curriculum", Teach Engineering, accessed February 28, 2023, http://www.teachengineering.org/curriculum/browse?subjectArea=Physics.

Recommended Course Activities:

Course activities may include:

- Career awareness seminars: Students research and make connections between STEM careers, such as physicist, mechanical engineer, researcher, and medical physicist, and the academic content covered.
- Speaker Series: Unique speaker events meant to connect students with diverse professionals in STEM fields are held.
- Research Lab Tours: Students visit research labs on campus aligned with the content covered in class, allowing students to make the connection between academic content and its application to research.
- Research symposium and prototype design presentations: After students complete and test their working/physical model prototype, they present their results to other teams and discuss possible modifications that can be made to improve design. The research symposium occurs at the end of the course, and students present their research to multiple stakeholders.
- Engineering design challenges: Students work as a team to solve open-ended design challenges. The challenges allow students to apply physics principles to solve real-word problems. Examples include designing an attenuator to absorb the impact of a vehicle collision in a work zone and designing a car that travels the greatest distance per band wind (vehicle efficiency).
- Classroom discourse: Allow students to periodically discuss ideas and content with teacher and classmates to help solidify understanding and address misconceptions.
- Design reflections: Students write a reflection on how well their working/physical model prototype worked, if it would help solve the problem, potential constraints, and what could be done differently next time.

Suggested methods for evaluating student outcomes:

Methods for evaluating student outcomes:

- Final exam assessment for course, used to determine mastery of course content
- Multi-dimensional performance assessments and rubrics
- Student reflections
- Traditional assessments incorporating three levels of thinking, reproduction, connections, and analysis. Item types include writing prompts, open-ended questions and multiple-choice questions
- Student designing infographics
- Quizzes
- Exit tickets
- Summative projects
- Summative writing prompts

Teacher qualifications:

- Master Science Teacher (Grades 8-12)
- Mathematics/Physical Science/Engineering: Grades 6-12
- Mathematics/Physical Science/Engineering: Grades 8-12
- Physical Science: Grades 6-12
- Physical Science: Grades 8-12
- Physics/Mathematics: Grades 7-12
- Physics/Mathematics: Grades 8-12
- Science: Grades 7-12
- Science: Grades 8-12
- Science, Technology, Engineering, and Mathematics: Grades 6-12
- Secondary Industrial Arts (Grades 6-12)
- Secondary Industrial Technology (Grades 6-12)
- Secondary Physics (Grades 6-12)
- Secondary Science (Grades 6-12)
- Secondary Science, Composite (Grades 6-12)
- Master Mathematics Teacher (Grades 8-12)
- Mathematics: Grades 7-12
- Mathematics: Grades 8-12
- Secondary Mathematics: Grades 6-12
- Principles of Applied Engineering, Grades 9-12
- Scientific Research and Design, Grades 9-12
- Computer Science: (8-12)
- Technology Applications: Early Childhood-Grade 12
- Technology Applications: Grades 8-12

Additional information:

There is no required training for TexPREP II- Engineering Physics and Integrated Algebra course. However, it is strongly recommended that each district develop its own professional development schedule to preview curriculum and instructional strategies with teachers. Curriculum documentation files are available upon request. Periodic opportunities for curriculum review and general preparation may be offered by the UTSA TexPREP program curriculum and professional development team. There is no cost associated with this professional development. Additionally, recorded professional development units will be readily made available to TexPREP to teachers. Curriculum documentation files and recordings may be requested by emailing prep@utsa.edu.