Texas Prefreshman Engineering Program (TexPREP) IV: Innovations in Engineering

PEIMS Code: N1303755

Abbreviation: TXPRENG4

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 IV: Innovations in Engineering is a project-based course in which students develop the ability to understand, contextualize, and analyze engineering designs and systems. Students will apply skills such as problem identification, scientific investigation, engineering design, data collection, data analysis, formulation, and presentation of conclusions. Students learn to lead the design of products, services and technologies with a human-centered approach to help solve the needs of society. This course provides students with an understanding of the design process, research methodologies and innovation strategies in emerging STEM fields, such as materials science, nanotechnology, data science or cybersecurity.

Essential Knowledge and Skills:

(a) General Requirements. This course is recommended for students grades 9-12. Required prerequisite: TexPREP II and TexPREP III or Chemistry. 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 IV: Innovations in Engineering is a project-based course in which students develop the ability to understand, contextualize, and analyze engineering designs and systems.

Students will apply skills such as problem identification, scientific investigation, engineering design, data collection, data analysis, formulation, and presentation of conclusions. Students learn to lead the design of products, services and technologies with a human-centered approach to help solve the needs of society. This course provides students with an understanding of the design process, research methodologies and innovation strategies in emerging STEM fields, such as materials science, nanotechnology, data science or cybersecurity.

(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" as intended as possible illustrative examples.

(c) Knowledge and Skills.

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

(A) define and demonstrate skills of how to dress, speak politely, and conduct oneself in a manner appropriate for the profession;

(B) apply skills in cooperation and collaboration as a member of a group in an effort to achieve a positive collective outcome;

(C) devise and justify actions using clear, concise, and effective written and oral communication; and

(D) formulate task schedules and performance goals for projects to support efficient results in a timely manner.

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

(A) assess the impact new technologies in materials science, nanotechnology, data science, or cybersecurity can have on society and the environment, including impacts that were not anticipated;

(B) relate the impact of past and current research on scientific thought, engineering practices and society, including contributions of diverse scientists and engineers in materials science, nanotechnology, data science, or cybersecurity; and

(C) analyze the benefits of a technological system to design products, services, and technologies that help solve societal problems.

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

(A) use a variety of resources, such as scales, construction tools, kitchen measurement tools, sound recording devices, and digital devices, to gather authentic data in support of arguments, findings, or lines of reasoning;

(B) explain the impacts of engineering contributions of historical and contemporary engineers and scientists in the fields of materials science, nanotechnology, data science, or cybersecurity on scientific thought and society;

(C) evaluate well-reasoned arguments based on data and concepts from other subjects to explain phenomena, validate conjectures, or support positions; and

(D) interpret data to derive meaning and select evidence-based arguments or evaluate designs.

(4) Innovations in engineering. The student designs a product, process, or service implementing appropriate innovation engineering design process with a human-centered approach to solve a real-world problem. The student is expected to:

(A) identify and evaluate existing engineering innovations in materials science, nanotechnology, data science, or cyber security through collaboration with scientific researchers or other members of the scientific community;

(B) use an engineering notebook to record ideas, sketches, prototypes, corrections, and improvements in the innovative design process;

(C) assess the consumer needs, manufacturability, cost and constraints related to production process to develop a product, process, or service;

(D) design and develop an innovative product, process, or service as a solution to a real-world problem in materials science, nanotechnology, data science, or cyber security; and

(E) evaluate the benefits and issues of a design solution.

(5) Innovations in engineering. The student explores the foundational concepts of an advance discipline-specific STEM course, such as materials science, nanotechnology, data science, and cybersecurity. The student is expected to:

(A) develop and implement advanced technical knowledge, concepts, and skills including collaboration, reflection, gathering data, constructing explanations, and designing innovative engineering solutions;

(B) develop content knowledge in materials science, nanotechnology, data science, or cybersecurity;

(C) test and evaluate proposed solutions to open-ended real-world problems using engineering methods such as creating models, prototypes, mockups, or simulations or performing critical design review, statistical analysis or experiments;

(D) communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports; and

(E) apply mathematical modeling to solve complex real-world problems.

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 lasers, beakers, graduated cylinder, goggles, apron, hot plates, etc. Equipment varies depending on resources available at the college/university site hosting the program.
- Engineering notebook

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

"Materials & Nonotechnology", American Chemistry Society, accessed March 1, 2023, http://www.acs.org/education/students/highschool/chemistyclubs/activities/materials.html.

"Educator Resources", ASM Materials Education Foundation, accessed March 1, 2023, http://www. https://www.asmfoundation.org/teachers/educator-resources/.

"Introduction to this exploration", Classroom of the Future Foundation, accessed March 1, 2023, http://www. https://sites.google.com/view/cybercareerdiscovery/introduction-to-this-exploration?authuser=0.

"High School Nanotechnology Summer Camp Framework", National Informal STEM Education Network, accessed March 1, 2023, https://www.nisenet.org/catalog/high-school-nanotechnology-summer-camp-framework.

Recommended Course Activities:

Course activities may include:

- Career awareness seminars: Students research and make connections between STEM careers, such as chemist, materials scientist, physicist, software engineer, data analyst, and biomedical engineer, 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 3D printing prototype, they present their results to other teams and discuss possible

modifications that can be made to improve their 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 mathematical and science concepts to design a prototype.
- 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 based on how well their 3D printing 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: including writing prompts, open-ended questions, multiple choice questions,
- Student designed infographics
- Quizzes
- Exit tickets
- Summative project
- 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 IV- Innovations in Engineering course. However, it is strongly recommended that each site 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 and recordings may be requested by emailing prep@utsa.edu.