130.373. Engineering Design and Problem Solving (One Science Credit).

(a) General requirements. This course is recommended for students in Grades 11-12. Prerequisites: Geometry, Algebra II, Chemistry, and Physics.

(b) Introduction.

(1) Engineering design is the creative process of solving problems by identifying needs and then devising solutions. This solution may be a product, technique, structure, process, or many other things depending on the problem. Science aims to understand the natural world, while engineering seeks to shape this world to meet human needs and wants. Engineering design takes into consideration limiting factors or "design under constraint." Various engineering disciplines address a broad spectrum of design problems using specific concepts from the sciences and mathematics to derive a solution. The design process and problem solving are inherent to all engineering disciplines.

(2) Engineering Design and Problem Solving reinforces and integrates skills learned in previous mathematics and science courses. This course emphasizes solving problems, moving from well defined toward more open ended, with real-world application. Students apply critical-thinking skills to justify a solution from multiple design options. Additionally, the course promotes interest in and understanding of career opportunities in engineering.

(3) This course is intended to stimulate students' ingenuity, intellectual talents, and practical skills in devising solutions to engineering design problems. Students use the engineering design process cycle to investigate, design, plan, create, and evaluate solutions. At the same time, this course fosters awareness of the social and ethical implications of technological development.

(c) Knowledge and skills.

(1) The student, for at least 40% of instructional time, conducts engineering field and laboratory activities using safe, environmentally appropriate, and ethical practices. The student is expected to:

   (A) demonstrate safe practices during engineering field and laboratory activities; and

   (B) make informed choices in the use and conservation of resources, recycling of materials, and the safe and legal disposal of materials.

(2) The student applies knowledge of science and mathematics and the tools of technology to solve engineering design problems. The student is expected to:

   (A) apply scientific processes and concepts outlined in the Texas Essential Knowledge and Skills (TEKS) for Biology, Chemistry, or Physics relevant to engineering design problems;
(B) apply concepts, procedures, and functions outlined in the TEKS for Algebra I, Geometry, and Algebra II relevant to engineering design problems;

(C) select appropriate mathematical models to develop solutions to engineering design problems;

(D) integrate advanced mathematics and science skills as necessary to develop solutions to engineering design problems;

(E) judge the reasonableness of mathematical models and solutions;

(F) investigate and apply relevant chemical, mechanical, biological, electrical, and physical properties of materials to engineering design problems;

(G) identify the inputs, processes, outputs, control, and feedback associated with open and closed systems;

(H) describe the difference between open-loop and closed-loop control systems;

(I) make measurements and specify tolerances with minimum necessary accuracy and precision;

(J) use appropriate measurement systems, including customary and International System (SI) of units; and

(K) use conversions between measurement systems to solve real-world problems.

(3) The student communicates through written documents, presentations, and graphic representations using the tools and techniques of professional engineers. The student is expected to:

(A) communicate visually by sketching and creating technical drawings using established engineering graphic tools, techniques, and standards;

(B) read and comprehend technical documents, including specifications and procedures;

(C) prepare written documents such as memorandums, emails, design proposals, procedural directions, letters, and technical reports using the formatting and terminology conventions of technical documentation;

(D) organize information for visual display and analysis using appropriate formats for various audiences, including, but not limited to, graphs and tables;

(E) evaluate the quality and relevance of sources and cite appropriately; and

(F) defend a design solution in a presentation.
(4) The student recognizes the history, development, and practices of the engineering professions. The student is expected to:

(A) identify and describe career options, working conditions, earnings, and educational requirements of various engineering disciplines such as those listed by the Texas Board of Professional Engineers;

(B) recognize that engineers are guided by established codes emphasizing high ethical standards;

(C) explore the differences, similarities, and interactions among engineers, scientists, and mathematicians;

(D) describe how technology has evolved in the field of engineering and consider how it will continue to be a useful tool in solving engineering problems;

(E) discuss the history and importance of engineering innovation on the United States economy and quality of life; and

(F) describe the importance of patents and the protection of intellectual property rights.

(5) The student creates justifiable solutions to open-ended problems using engineering design practices and processes. The student is expected to:

(A) identify and define an engineering problem;

(B) formulate goals, objectives, and requirements to solve an engineering problem;

(C) determine the design parameters associated with an engineering problem such as materials, personnel, resources, funding, manufacturability, feasibility, and time;

(D) establish and evaluate constraints pertaining to a problem, including, but not limited to, health, safety, social, environmental, ethical, political, regulatory, and legal;

(E) identify or create alternative solutions to a problem using a variety of techniques such as brainstorming, reverse engineering, and researching engineered and natural solutions;

(F) test and evaluate proposed solutions using methods such as models, prototypes, mock-ups, simulations, critical design review, statistical analysis, or experiments;

(G) apply structured techniques to select and justify a preferred solution to a problem such as a decision tree, design matrix, or cost-benefit analysis;

(H) predict performance, failure modes, and reliability of a design solution; and
(I) prepare a project report that clearly documents the designs, decisions, and activities during each phase of the engineering design process.

(6) The student manages an engineering design project. The student is expected to:

(A) participate in the design and implementation of a real or simulated engineering project;

(B) develop a plan and timeline for completion of a project;

(C) work in teams and share responsibilities, acknowledging, encouraging, and valuing contributions of all team members;

(D) compare and contrast the roles of a team leader and other team responsibilities;

(E) identify and manage the resources needed to complete a project;

(F) use a budget to determine effective strategies to meet cost constraints;

(G) create a risk assessment for an engineering design project;

(H) analyze and critique the results of an engineering design project; and

(I) maintain an engineering notebook that chronicles work such as ideas, concepts, inventions, sketches, and experiments.

Source: The provisions of this §130.373 adopted to be effective August 23, 2010, 34 TexReg 5941.