Principles of Applied Engineering

Subject: Career and Technical Education
Grade: 09
Expectations: 66
Breakouts: 184

(a) Introduction.

1. Career and technical education instruction provides content aligned with challenging academic standards, industry-relevant technical knowledge, and college and career readiness skills for students to further their education and succeed in current and 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. Principles of Applied Engineering provides an overview of the various fields of science, technology, engineering, and mathematics and their interrelationships. Students develop engineering communication skills, which include computer graphics, modeling, and presentations, by using a variety of computer hardware and software applications to complete assignments and projects. Upon completing this course, students will have an understanding of the various fields of engineering and be able to make informed career decisions.

4. Students are encouraged to participate in extended learning experiences such as career and technical student 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.

(b) Knowledge and Skills Statements

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

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

(i) demonstrate knowledge of how to dress appropriately for the profession

(ii) demonstrate knowledge of how to speak politely for the profession

(iii) demonstrate knowledge of how to conduct oneself in a manner appropriate for the profession

(B) cooperate, contribute, and collaborate as a member of a group in an effort to achieve a positive collective outcome;

(i) cooperate as a member of a group in an effort to achieve a positive collective outcome

(ii) contribute as a member of a group in an effort to achieve a positive collective outcome

(iii) collaborate as a member of a group in an effort to achieve a positive collective outcome

(C) present written and oral communication in a clear, concise, and effective manner;

(i) present written communication in a clear manner

(ii) present written communication in a concise manner

(iii) present written communication in [an] effective manner

(iv) present oral communication in a clear manner

(v) present oral communication in a concise manner

(vi) present oral communication in [an] effective manner

(D) demonstrate time-management skills in prioritizing tasks, following schedules, and performing goal-relevant activities in a way that produces efficient results; and

(i) demonstrate time-management skills in prioritizing tasks in a way that produces efficient results

(ii) demonstrate time-management skills in following schedules in a way that produces efficient results

(iii) demonstrate time-management skills in performing goal-relevant activities in a way that produces efficient results

(E) demonstrate punctuality, dependability, reliability, and responsibility in performing assigned tasks.

(i) demonstrate punctuality in performing assigned tasks

(ii) demonstrate dependability in performing assigned tasks

(iii) demonstrate reliability in performing assigned tasks

(iv) demonstrate responsibility in performing assigned tasks

(2) The student investigates the components of engineering and technology systems. The student is expected to:

(A) investigate and report on the history of engineering disciplines, including chemical, civil, electrical, and mechanical engineering;

(i) investigate the history of engineering disciplines, including chemical engineering

(ii) investigate the history of engineering disciplines, including civil engineering

(iii) investigate the history of engineering disciplines, including electrical engineering

(iv) investigate the history of engineering disciplines, including mechanical engineering

(v) report on the history of engineering disciplines, including chemical engineering

(vi) report on the history of engineering disciplines, including civil engineering

(vii) report on the history of engineering disciplines, including electrical engineering

(viii) report on the history of engineering disciplines, including mechanical engineering

(B) identify the inputs, processes, and outputs associated with technological systems;

(i) identify the inputs associated with technological systems

(ii) identify the processes associated with technological systems

(iii) identify the outputs associated with technological systems

(C) describe the difference between open and closed systems;

(i) describe the difference between open and closed systems

(D) describe how technological systems interact to achieve common goals;

(i) describe how technological systems interact to achieve common goals

(E) compare engineering, science, and technology career paths, including entry-level employment, military service, apprenticeships, community and technical colleges, and universities;

(i) compare engineering, science, and technology career paths, including entry-level employment

(ii) compare engineering, science, and technology career paths, including military service

(iii) compare engineering, science, and technology career paths, including apprenticeships

(iv) compare engineering, science, and technology career paths, including technical colleges

(v) compare engineering, science, and technology career paths, including community colleges

(vi) compare engineering, science, and technology career paths, including universities

(F) conduct and present research on emerging and innovative technology; and

(i) conduct research on emerging technology

(ii) conduct research on innovative technology

(iii) present research on emerging technology

(iv) present research on innovative technology

(G) demonstrate proficiency of the engineering design process.

(i) demonstrate proficiency of the engineering design process

(3) The student presents conclusions, research findings, and designs using a variety of media throughout the course. The student is expected to:

(A) use clear and concise written, verbal, and visual communication techniques;

(i) use clear written communication techniques

(ii) use clear verbal communication techniques

(iii) use clear visual communication techniques

(iv) use concise written communication techniques

(v) use concise verbal communication techniques

(vi) use concise visual communication techniques

(B) maintain a design and computation engineering notebook;

(i) maintain a design and computation engineering notebook

(C) develop and present ideas using sketching and computer-aided design and drafting (CADD);

(i) develop ideas using sketching

(ii) develop ideas using computer-aided design and drafting (CADD)

(iii) present ideas using sketching

(iv) present ideas using computer-aided design and drafting (CADD)

(D) draw conclusions using industry-standard visualization techniques and media;

(i) draw conclusions using industry-standard visualization techniques

(ii) draw conclusions using industry-standard visualization media

(E) maintain a paper or digital portfolio using the engineering documentation process; and

(i) maintain a paper or digital portfolio using the engineering documentation process

(F) use collaborative tools such as desktop or web-based applications to share and develop information.

(i) use collaborative tools to share information

(ii) use collaborative tools to develop information

(4) The student uses appropriate tools and demonstrates safe work habits. The student is expected to:

(A) master relevant safety tests;

(i) master relevant safety tests

(B) follow lab safety guidelines as prescribed by instructor in compliance with local, state, and federal regulations;

(i) follow lab safety guidelines as prescribed by instructor in compliance with local regulations

(ii) follow lab safety guidelines as prescribed by instructor in compliance with state regulations

(iii) follow lab safety guidelines as prescribed by instructor in compliance with federal regulations

(C) identify industry safety terminology related to the personal work environment such as Occupational Safety and Health Administration (OSHA), American Society of Mechanical Engineers (ASME), and personal protective equipment (PPE);

(i) identify industry safety terminology related to the personal work environment

(D) recognize the classification of hazardous materials and wastes;

(i) recognize the classification of hazardous materials

(ii) recognize the classification of hazardous wastes

(E) describe appropriate ways to dispose of hazardous materials and wastes;

(i) describe appropriate ways to dispose of hazardous materials

(ii) describe appropriate ways to dispose of hazardous wastes

(F) maintain, safely handle, and properly store laboratory equipment;

(i) maintain laboratory equipment

(ii) safely handle laboratory equipment

(iii) properly store laboratory equipment

(G) describe the implications of negligent or improper maintenance; and

(i) describe the implications of negligent or improper maintenance

(H) demonstrate the use of precision measuring instruments.

(i) demonstrate the use of precision measuring instruments

(5) The student describes the factors that affect the progression of technology and analyzes the potential intended and unintended consequences of technological advances. The student is expected to:

(A) describe how technology has affected individuals, societies, cultures, economies, and environments;

(i) describe how technology has affected individuals

(ii) describe how technology has affected societies

(iii) describe how technology has affected cultures

(iv) describe how technology has affected economies

(v) describe how technology has affected environments

(B) describe how the development and use of technology influenced past events;

(i) describe how the development of technology influenced past events

(ii) describe how the use of technology influenced past events

(C) describe how and why technology progresses; and

(i) describe how technology progresses

(ii) describe why technology progresses

(D) predict possible changes caused by the advances of technology.

(i) predict possible changes caused by the advances of technology

(6) The student thinks critically and applies fundamental principles of system modeling and design to multiple design projects. The student is expected to:

(A) identify and describe an engineering design process needed for a project, including the design process and prototype development and initiating, planning, executing, monitoring and controlling, and closing a project;

(i) identify an engineering design process needed for a project, including the design process

(ii) identify an engineering design process needed for a project, including prototype development

(iii) identify an engineering design process needed for a project, including initiating a project

(iv) identify an engineering design process needed for a project, including planning a project

(v) identify an engineering design process needed for a project, including executing a project

(vi) identify an engineering design process needed for a project, including monitoring and controlling a project

(vii) identify an engineering design process needed for a project, including closing a project

(viii) describe an engineering design process needed for a project, including the design process

(ix) describe an engineering design process needed for a project, including prototype development

(x) describe an engineering design process needed for a project, including initiating a project

(xi) describe an engineering design process needed for a project, including planning a project

(xii) describe an engineering design process needed for a project, including executing a project

(xiii) describe an engineering design process needed for a project, including monitoring and controlling a project

(xiv) describe an engineering design process needed for a project, including closing a project

(B) identify the chemical, mechanical, and physical properties of engineering materials and identify testing methods associated with the materials;

(i) identify the chemical properties of engineering materials

(ii) identify the mechanical properties of engineering materials

(iii) identify the physical properties of engineering materials

(iv) identify testing methods associated with the [engineering] materials

(C) use problem-solving techniques to develop technological solutions such as product, process, or system;

(i) use problem-solving techniques to develop technological solutions

(D) use consistent units for all measurements and computations; and

(i) use consistent units for all measurements

(ii) use consistent units for all computations

(E) assess the risks and benefits of a design solution.

(i) assess the risks of a design solution

(ii) assess the benefits of a design solution

(7) The student understands the opportunities and careers in fields related to robotics, process control, and automation systems. The student is expected to:

(A) describe applications of robotics, process control, and automation systems;

(i) describe applications of robotics

(ii) describe applications of process control

(iii) describe applications of automation systems

(B) apply design concepts to problems in robotics, process control, and automation systems;

(i) apply design concepts to problems in robotics

(ii) apply design concepts to problems in process control

(iii) apply design concepts to problems in automation systems

(C) identify fields and career opportunities related to robotics, process control, and automation systems; and

(i) identify fields related to robotics

(ii) identify fields related to process control

(iii) identify fields related to automation systems

(iv) identify career opportunities related to robotics

(v) identify career opportunities related to process control

(vi) identify career opportunities related to automation systems

(D) identify emerging trends in robotics, process control, and automation systems.

(i) identify emerging trends in robotics

(ii) identify emerging trends in process control

(iii) identify emerging trends in automation systems

(8) The student understands the opportunities and careers in fields related to electrical and mechanical systems. The student is expected to:

(A) describe the applications of electrical and mechanical systems;

(i) describe the applications of electrical systems

(ii) describe the applications of mechanical systems

(B) describe career opportunities in electrical and mechanical systems;

(i) describe career opportunities in electrical systems

(ii) describe career opportunities in mechanical systems

(C) identify emerging trends in electrical and mechanical systems; and

(i) identify emerging trends in electrical systems

(ii) identify emerging trends in mechanical systems

(D) describe and apply basic electronic theory.

(i) describe basic electronic theory

(ii) apply basic electronic theory

(9) The student collaborates as a team member while completing a comprehensive project. The student is expected to:

(A) apply the design process, including decision matrices, as a team participant;

(i) apply the design process, including decision matrices, as a team participant

(B) perform different roles within the project as a team member;

(i) perform different roles within the project as a team member

(C) formulate decisions using collaborative strategies such as decision and design matrices and conflict resolution;

(i) formulate decisions using collaborative strategies

(D) maintain an engineering notebook for the project;

(i) maintain an engineering notebook for the project

(E) develop and test the model for the project; and

(i) develop the model for the project

(ii) test the model for the project

(F) demonstrate communication skills by preparing and presenting the project, including building consensus setback resolution and decision matrices.

(i) demonstrate communication skills by preparing the project, including building consensus setback resolution matrices

(ii) demonstrate communication skills by preparing the project, including decision matrices

(iii) demonstrate communication skills by presenting the project, including building consensus setback resolution matrices

(iv) demonstrate communication skills by presenting the project, including decision matrices

(10) The student demonstrates a knowledge of drafting by completing a series of drawings that can be published by various media. The student is expected to:

(A) set up, create, and modify drawings;

(i) set up drawings

(ii) create drawings

(iii) modify drawings

(B) store and retrieve geometry;

(i) store geometry

(ii) retrieve geometry

(C) demonstrate and use appropriate line types in engineering drawings;

(i) demonstrate appropriate line types in engineering drawings

(ii) use appropriate line types in engineering drawings

(D) draw two-dimensional, single-view objects;

(i) draw two-dimensional, single-view objects

(E) create multi-view working drawings using orthographic projection;

(i) create multi-view working drawings using orthographic projection

(F) dimension objects using current American National Standards Institute (ANSI) standards;

(i) dimension objects using current American National Standards Institute (ANSI) standards

(G) draw single-line two-dimensional pictorial representations; and

(i) draw single-line two-dimensional pictorial representations

(H) create working drawings that include section views.

(i) create working drawings that include section views

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

(A) identify and define an engineering problem;

(i) identify an engineering problem

(ii) define an engineering problem

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

(i) formulate goals to solve an engineering problem

(ii) formulate objectives to solve an engineering problem

(iii) formulate requirements to solve an engineering problem

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

(i) determine the design parameters associated with an engineering problem

(D) establish and evaluate potential constraints, including health, safety, social, environmental, ethical, political, regulatory, and legal, pertaining to a problem;

(i) establish constraints, including health, pertaining to [an engineering] problem

(ii) establish constraints, including safety, pertaining to [an engineering] problem

(iii) establish constraints, including social, pertaining to a problem

(iv) establish constraints, including environmental, pertaining to [an engineering] problem

(v) establish constraints, including ethical, pertaining to [an engineering] problem

(vi) establish constraints, including political, pertaining to [an engineering] problem

(vii) establish constraints, including regulatory, pertaining to [an engineering] problem

(viii) establish constraints, including legal, pertaining to [an engineering] problem

(ix) evaluate constraints, including health, pertaining to [an engineering] problem

(x) evaluate constraints, including safety, pertaining to [an engineering] problem

(xi) evaluate constraints, including social, pertaining to [an engineering] problem

(xii) evaluate constraints, including environmental, pertaining to [an engineering] problem

(xiii) evaluate constraints, including ethical, pertaining to [an engineering] problem

(xiv) evaluate constraints, including political, pertaining to [an engineering] problem

(xv) evaluate constraints, including regulatory, pertaining to [an engineering] problem

(xvi) evaluate constraints, including legal, pertaining to [an engineering] problem

(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;

(i) identify or create alternative solutions to a problem using a variety of techniques

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

(i) test proposed solutions using engineering methods

(ii) evaluate proposed solutions using engineering methods

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

(i) apply structured techniques to select a preferred solution to a problem

(ii) apply structured techniques to justify a preferred solution to a problem

(H) predict performance, failure modes, and reliability of a design solution; and

(i) predict performance of a design solution

(ii) predict failure modes of a design solution

(iii) predict reliability of a design solution

(I) prepare a project report that clearly documents the designs, decisions, and activities during each phase of the engineering design process.

(i) prepare a project report that clearly documents the designs during each phase of the engineering design process

(ii) prepare a project report that clearly documents the decisions during each phase of the engineering design process

(iii) prepare a project report that clearly documents the activities during each phase of the engineering design process