Engineering Design and Presentation II

Subject: Career and Technical Education
Grade: 11
Expectations: 73
Breakouts: 213

(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. Engineering Design and Presentation II is a continuation of knowledge and skills learned in Engineering Design and Presentation I. Students enrolled in this course will demonstrate advanced knowledge and skills of a system design process as it applies to engineering fields and project management using multiple software applications and tools necessary to produce and present working drawings, solid model renderings, and prototypes. Students will expand on the use of a variety of computer hardware and software applications to complete assignments and projects. Through implementation of a system design process, students will transfer advanced academic skills to component designs and engineering systems. Emphasis will be placed on transdisciplinary and integrative approaches using skills from ideation, prototyping, and project management methods.

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) distinguish between an engineering technician, engineering technologist, and engineer;

(i) distinguish between an engineering technician, engineering technologist, and engineer

(B) identify employment and career opportunities in engineering and describe the educational requirements for each;

(i) identify employment opportunities in engineering

(ii) identify career opportunities in engineering

(iii) describe the educational requirements for [employment opportunities in engineering]

(iv) describe the educational requirements for [career opportunities in engineering]

(C) investigate and describe the requirements of industry-based certifications in engineering;

(i) investigate the requirements of industry-based certifications in engineering

(ii) describe the requirements of industry-based certifications in engineering

(D) demonstrate the principles of teamwork related to engineering and technology;

(i) demonstrate the principles of teamwork related to engineering

(ii) demonstrate the principles of teamwork related to technology

(E) research and describe governmental regulations, including health and safety;

(i) research governmental regulations, including health

(ii) research governmental regulations, including safety

(iii) describe governmental regulations, including health

(iv) describe governmental regulations, including safety

(F) analyze ethical issues related to engineering and technology and incorporate proper ethics in submitted projects;

(i) analyze ethical issues related to engineering

(ii) analyze ethical issues related to technology

(iii) incorporate proper ethics in submitted projects

(G) demonstrate respect for diversity in the workplace;

(i) demonstrate respect for diversity in the workplace

(H) identify consequences relating to discrimination, harassment, and inequality;

(i) identify consequences relating to discrimination

(ii) identify consequences relating to harassment

(iii) identify consequences relating to inequality

(I) demonstrate effective oral and written communication skills using a variety of software applications and media; and

(i) demonstrate effective oral communication skills using a variety of software applications

(ii) demonstrate effective oral communication skills using a variety of media

(iii) demonstrate effective written communication skills using a variety of software applications

(iv) demonstrate effective written communication skills using a variety of media

(J) investigate and present on career preparation learning experiences, including job shadowing, mentoring, and apprenticeship training.

(i) investigate career preparation learning experiences, including job shadowing

(ii) investigate career preparation learning experiences, including mentoring

(iii) investigate career preparation learning experiences, including apprenticeship training

(iv) present on career preparation learning experiences, including job shadowing

(v) present on career preparation learning experiences, including mentoring

(vi) present on career preparation learning experiences, including apprenticeship training

(2) The student participates in team projects in various roles. The student is expected to:

(A) describe the various roles on an engineering team and discuss how teams function;

(i) describe the various roles on an engineering team

(ii) discuss how [engineering] teams function

(B) demonstrate teamwork to solve problems; and

(i) demonstrate teamwork to solve problems

(C) serve as a team leader and member and demonstrate appropriate attitudes while participating in team projects.

(i) serve as a team leader

(ii) serve as a team member

(iii) demonstrate appropriate attitudes while participating in team projects

(3) The student develops skills for managing a project. The student is expected to:

(A) create, implement, and evaluate project management methodologies, including initiating, planning, executing, monitoring and controlling, and closing a project;

(i) create project management methodologies, including initiating a project

(ii) create project management methodologies, including planning a project

(iii) create project management methodologies, including executing a project

(iv) create project management methodologies, including monitoring and controlling a project

(v) create project management methodologies, including closing a project

(vi) implement project management methodologies, including initiating a project

(vii) implement project management methodologies, including planning a project

(viii) implement project management methodologies, including executing a project

(ix) implement project management methodologies, including monitoring and controlling

(x) implement project management methodologies, including closing a project

(xi) evaluate project management methodologies, including initiating a project

(xii) evaluate project management methodologies, including planning a project

(xiii) evaluate project management methodologies, including executing a project

(xiv) evaluate project management methodologies, including monitoring and controlling a project

(xv) evaluate project management methodologies, including closing a project

(B) develop a project schedule and complete projects according to established criteria;

(i) develop a project schedule

(ii) complete projects according to established criteria

(C) use strategies such as decision matrices, flow charts, or Gantt charts to maintain the project schedule and quality of project.

(i) use strategies to maintain the project schedule

(ii) use strategies to maintain the quality of project

(D) participate in the organization and operation of a real or simulated engineering project; and

(i) participate in the organization of a real or simulated engineering project

(ii) participate in the operation of a real or simulated engineering project

(E) develop a plan for production of an individual product.

(i) develop a plan for production of an individual product

(4) The student demonstrates principles of project documentation, workflow, and evaluated results. The student is expected to:

(A) complete work orders and related documentation;

(i) complete work orders

(ii) complete documentation [related to work orders]

(B) identify and defend factors affecting cost and strategies to minimize costs;

(i) identify factors affecting cost

(ii) identify factors affecting strategies to minimize costs

(iii) defend factors affecting cost

(iv) defend factors affecting strategies to minimize costs

(C) formulate a project budget;

(i) formulate a project budget

(D) develop a production schedule;

(i) develop a production schedule

(E) identify intellectual property and other legal restrictions; and

(i) identify intellectual property

(ii) identify other legal restrictions

(F) read and interpret technical drawings, manuals, and bulletins.

(i) read technical drawings

(ii) read manuals

(iii) read bulletins

(iv) interpret technical drawings

(v) interpret manuals

(vi) interpret bulletins

(5) The student applies the concepts and skills of computer-aided drafting and design software to perform the following tasks. The student is expected to:

(A) prepare drawings to American National Standards Institute (ANSI) and International Organization for Standardization (ISO) graphic standards;

(i) prepare drawings to American National Standards Institute (ANSI) graphic standards

(ii) prepare drawings to International Organization for Standardization (ISO) graphic standards

(B) customize software user interface;

(i) customize software user interface

(C) prepare and use advanced views such as auxiliary, section, and break-away;

(i) prepare advanced views

(ii) use advanced views

(D) draw detailed parts, assembly diagrams, and sub-assembly diagrams;

(i) draw detailed parts

(ii) draw detailed assembly diagrams

(iii) draw detailed sub-assembly diagrams

(E) indicate tolerances and standard fittings using appropriate library functions;

(i) indicate tolerances using appropriate library functions

(ii) indicate standard fittings using appropriate library functions

(F) demonstrate understanding of annotation styles and setup by defining units, fonts, dimension styles, notes, and leader lines;

(i) demonstrate understanding of annotation styles defining units

(ii) demonstrate understanding of annotation styles by defining fonts

(iii) demonstrate understanding of annotation styles by defining dimension styles

(iv) demonstrate understanding of annotation styles by defining notes

(v) demonstrate understanding of annotation styles by defining leader lines

(vi) demonstrate understanding of annotation setup defining units

(vii) demonstrate understanding of annotation setup by defining fonts

(viii) demonstrate understanding of annotation setup by defining dimension styles

(ix) demonstrate understanding of annotation setup by defining notes

(x) demonstrate understanding of annotation setup by defining leader lines

(G) identify and incorporate the use of advanced layout techniques and viewports using paper-space and modeling areas;

(i) identify the use of advanced layout techniques using paper-space areas

(ii) identify the use of advanced layout techniques using modeling areas

(iii) identify the use of advanced layout viewports using paper-space areas

(iv) identify the use of advanced layout viewports using modeling areas

(v) incorporate the use of advanced layout techniques using paper-space areas

(vi) incorporate the use of advanced layout techniques using modeling areas

(vii) incorporate the use of advanced layout viewports using paper-space areas

(viii) incorporate the use of advanced layout viewports using modeling areas

(H) use management techniques by setting up properties to define and control individual layers;

(i) use management techniques by setting up properties to define individual layers

(ii) use management techniques by setting up properties to control individual layers

(I) create and use custom templates for advanced project management;

(i) create custom templates for advanced project management

(ii) use custom templates for advanced project management

(J) prepare and use advanced development drawings;

(i) prepare advanced development drawings

(ii) use advanced development drawings

(K) use advanced polar tracking and blocking techniques to increase drawing efficiency;

(i) use advanced polar tracking techniques to increase drawing efficiency

(ii) use advanced blocking techniques to increase drawing efficiency

(L) create drawings that incorporate external referencing;

(i) create drawings that incorporate external referencing

(M) create and render objects using parametric modeling tools; and

(i) create objects using parametric modeling tools

(ii) render objects using parametric modeling tools

(N) model individual parts or assemblies and produce rendered or animated output.

(i) model individual parts or assemblies

(ii) produce rendered output or animated output

(6) The student practices safe and proper work habits. The student is expected to:

(A) master relevant safety tests;

(i) master relevant safety tests

(B) comply with safety guidelines as described in various manuals, instructions, and regulations;

(i) comply with safety guidelines as described in various manuals

(ii) comply with safety guidelines as described in various instructions

(iii) comply with safety guidelines as described in various regulations

(C) identify and classify hazardous materials and wastes according to Occupational Safety and Health Administration (OSHA) regulations;

(i) identify hazardous materials according to Occupational Safety and Health Administration (OSHA) regulations

(ii) identify hazardous wastes according to Occupational Safety and Health Administration (OSHA) regulations

(iii) classify hazardous material according to Occupational Safety and Health Administration (OSHA) regulations

(iv) classify hazardous wastes according to Occupational Safety and Health Administration (OSHA) regulations

(D) describe the appropriate disposal of hazardous materials and wastes appropriately;

(i) describe the appropriate disposal of hazardous materials appropriately

(ii) describe the appropriate disposal of hazardous wastes appropriately

(E) perform maintenance on selected tools, equipment, and machines;

(i) perform maintenance on selected tools

(ii) perform maintenance on selected equipment

(iii) perform maintenance on selected machines

(F) handle and store tools and materials correctly; and

(i) handle tools correctly

(ii) handle materials correctly

(iii) store tools correctly

(iv) store materials correctly

(G) describe the results of negligent or improper maintenance.

(i) describe the results of negligent or improper maintenance

(7) The student uses engineering design methodologies. The student is expected to:

(A) describe principles of solution ideation and evaluate ideation techniques for an engineering project, including systems-based engineering and advanced prototyping;

(i) describe principles of solution ideation

(ii) evaluate ideation techniques for an engineering project, including systems-based engineering

(iii) evaluate ideation techniques for an engineering project, including advanced prototyping

(B) demonstrate critical thinking, identify the solution constraints, and make fact-based decisions;

(i) demonstrate critical thinking

(ii) identify the solution constraints

(iii) make fact-based decisions

(C) develop or improve a solution using rational thinking;

(i) develop or improve a solution using rational thinking

(D) apply decision-making strategies when developing solutions;

(i) apply decision-making strategies when developing solutions

(E) identify quality-control issues in engineering design and production;

(i) identify quality-control issues in engineering design

(ii) identify quality-control issues in production

(F) describe perceptions of the quality of products and how they affect engineering decisions;

(i) describe perceptions of the quality of products

(ii) describe how [perceptions of the quality of products] affect engineering decisions

(G) use an engineering notebook to record prototypes, corrections, and/or mistakes in the design process; and

(i) use an engineering notebook to record prototypes in the design process

(ii) use an engineering notebook to record corrections in the design process

(iii) use an engineering notebook to record mistakes in the design process

(H) use an engineering notebook or portfolio to record and justify the final design, construction, and manipulation of finished projects.

(i) use an engineering notebook or portfolio to record the final design of finished projects

(ii) use an engineering notebook or portfolio to record the construction of finished projects

(iii) use an engineering notebook or portfolio to record the manipulation of finished projects

(iv) use an engineering notebook or portfolio to justify the final design of finished projects

(v) use an engineering notebook or portfolio to justify the construction of finished projects

(vi) use an engineering notebook or portfolio to justify the manipulation of finished projects

(8) The student applies concepts of engineering to specific problems. The student is expected to:

(A) design solutions from various engineering disciplines such as electrical, mechanical, structural, civil, or biomedical engineering;

(i) design solutions from various engineering disciplines

(B) experiment with the use of tools, laboratory equipment, and precision measuring instruments to develop prototypes;

(i) experiment with the use of tools to develop prototypes

(ii) experiment with the use of laboratory equipment to develop prototypes

(iii) experiment with the use of precision measuring instruments to develop prototypes

(C) research different types of computer-aided drafting and design software and evaluate their applications for use in design systems and problem solving; and

(i) research different types of computer-aided drafting and design software

(ii) evaluate [computer-aided drafting and design software] applications for use in design systems

(iii) evaluate [computer-aided drafting and design software] applications for use in design systems use in problem solving

(D) use multiple software applications for concept presentations.

(i) use multiple software applications for concept presentations

(9) The student addresses a need or problem using appropriate systems engineering design processes and techniques. The student is expected to:

(A) create and interpret engineering drawings;

(i) create engineering drawings

(ii) interpret engineering drawings

(B) identify areas where quality, reliability, and safety and multidisciplinary optimization and stakeholder analysis can be designed into a solution such as a product, process, or system;

(i) identify areas where quality can be designed into a solution

(ii) identify areas where reliability can be designed into a solution

(iii) identify areas where safety can be designed into a solution

(iv) identify areas where multidisciplinary optimization can be designed into a solution

(v) identify areas where stakeholder analysis can be designed into a solution

(C) improve a system design, including properties of materials selected, to meet a specified need;

(i) improve a system design, including properties of materials selected, to meet a specified need

(D) produce engineering drawings to industry standards; and

(i) produce engineering drawings to industry standards

(E) describe potential patents and the patenting process.

(i) describe potential patents

(ii) describe the patenting process

(10) The student builds a prototype using the appropriate tools, materials, and techniques. The student is expected to:

(A) implement and delineate the steps needed to produce a prototype such as defining the problem and generating concepts;

(i) implement the steps needed to produce a prototype

(ii) delineate the steps needed to produce a prototype

(B) identify industry-appropriate tools, equipment, machines, and materials;

(i) identify industry-appropriate tools

(ii) identify industry-appropriate equipment

(iii) identify industry-appropriate machines

(iv) identify industry-appropriate materials

(C) fabricate the prototype using a systems engineering approach to compare the performance and use of materials; and

(i) fabricate the prototype using a systems engineering approach to compare the performance of materials

(ii) fabricate the prototype using a systems engineering approach to compare the use of materials

(D) present and validate the prototype using a variety of media and defend engineering practices used in the prototype.

(i) present the prototype using a variety of media

(ii) validate the prototype using a variety of media

(iii) defend engineering practices used in the prototype

(11) The student creates justifiable solutions to open-ended real-world problems within a multitude of engineering disciplines such as mechanical, electrical, civil, structural, bio, or aerospace using engineering design practices and processes. The student is expected to:

(A) identify and define engineering problems from different engineering disciplines such as mechanical, civil, structural, electrical, bio, or aerospace engineering;

(i) identify engineering problems from different engineering disciplines

(ii) define engineering problems from different engineering disciplines

(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 constraints of systems engineering, including health, safety, social, environmental, ethical, political, regulatory, and legal, pertaining to a problem;

(i) establish constraints of systems engineering, including health, pertaining to a problem

(ii) establish constraints of systems engineering, including safety, pertaining to a problem

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

(iv) establish constraints of systems engineering, including environmental, pertaining to a problem

(v) establish constraints of systems engineering, including ethical, pertaining to a problem

(vi) establish constraints of systems engineering, including political, pertaining to a problem

(vii) establish constraints of systems engineering, including regulatory, pertaining to a problem

(viii) establish constraints of systems engineering, including legal, pertaining to a problem

(ix) evaluate constraints of systems engineering, including health, pertaining to a problem

(x) evaluate constraints of systems engineering, including safety, pertaining to a problem

(xi) evaluate constraints of systems engineering, including social, pertaining to a problem

(xii) evaluate constraints of systems engineering, including environmental, pertaining to a problem

(xiii) evaluate constraints of systems engineering, including ethical, pertaining to a problem

(xiv) evaluate constraints of systems engineering, including political, pertaining to a problem

(xv) evaluate constraints of systems engineering, including regulatory, pertaining to a problem

(xvi) evaluate constraints of systems engineering, including legal, pertaining to a 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 tools and methods such as models, prototypes, mock-ups, simulations, critical design review, statistical analysis, or experiments; and

(i) test proposed solutions using tools

(ii) test proposed solutions using methods

(iii) evaluate proposed solutions using tools

(iv) evaluate proposed solutions using methods

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

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

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