

Engineering Practicum IV

8453 36 weeks

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Course Description

Suggested Grade Level: 11 or 12

Prerequisites: 8441 or 8451 or 8491

This course will enable students to examine technology and engineering fundamentals related to solving real-world problems. Students examine ethics and intellectual property and design a practicum project, a culmination of knowledge and skill gained in the previous engineering courses. In addition, students continue to investigate a variety of engineering specialty fields and related careers to determine whether they are good candidates for postsecondary educational opportunities in engineering.

Task Essentials Table

- Tasks/competencies designated by plus icons (⊕) in the left-hand column(s) are essential
- Tasks/competencies designated by empty-circle icons (○) are optional
- Tasks/competencies designated by minus icons (⊖) are omitted
- Tasks marked with an asterisk (*) are sensitive.

Task Number	8453	Tasks/Competencies
Examining Employability Skills		
39	⊕	Research a principal field of interest in engineering.
40	⊕	Identify educational requirements for the chosen field.
41	⊕	Research postsecondary education opportunities.
42	⊕	Compile requirements for Professional Engineering license.
43	⊕	Develop a professional résumé.
44	⊕	Complete the job application process.
45	⊕	Participate in a mock interview.
46	⊕	Build a complete work portfolio.
Examining the Design Process		
47	⊕	Define the engineering design process.
48	⊕	Analyze the similarities and differences between the engineering design process and the scientific method.
Examining Intellectual Property		
49	⊕	Summarize the National Society of Professional Engineers Code of Ethics.
50	⊕	Identify the types of intellectual property rights and how they are protected and enforced.
51	⊕	Define <i>patent</i> and its function.
52	⊕	Identify the patent application process.

53	⊕	Perform a patent search.	
54	⊕	Identify the legal consequences of patent violation.	
55	⊕	Explain the necessity of the marketing process.	
56	⊕	Evaluate safety of designs.	
57	⊕	Compare professional and personal ethics.	
58	⊕	Identify ethical theories (i.e., utilitarianism, duty, rights, virtue).	
Designing a Practicum Project			
59	⊕	Write an engineering technical report for your engineering practicum.	
60	⊕	Present a proposal to an engineering challenge.	
61	⊕	Peer review all proposals.	
62	⊕	Identify the need or opportunity for an engineering solution.	
63	⊕	Define a design problem.	
64	⊕	Identify the constraints of a design problem.	
65	⊕	Research potential solutions for a design problem.	
66	⊕	Generate new (i.e., original) solutions for the design problem.	
67	⊕	Evaluate potential solutions.	
68	⊕	Sketch/diagram solutions for a design problem.	
69	⊕	Identify potential risks involved with the solution(s).	
70	⊕	Research model-driven engineering.	
71	⊕	Create a model for the technological problem.	
72	⊕	Test the model's effectiveness in solving the design problem.	
73	⊕	Evaluate potential solutions to a design problem.	
74	⊕	Analyze potential risk list.	
75	⊕	Choose the optimal solution to a design problem based on constraints and original identified solutions.	

76	+	Develop a budget.
77	+	Create a work schedule.
78	+	Implement the solution to the design problem.
79	+	Communicate solution to stakeholders.
80	+	Test the solution.
81	+	Evaluate test results.
82	+	Improve the solution.
83	+	Deliver a final project presentation.
84	+	Document a final project report.
85	+	Develop a schedule using industry-standard software applications to ensure the solution can be completed during the course.
86	+	Research cost-estimation tools and methods in the engineering field.
87	+	Develop an engineering journal to compile important information.
88	+	Control engineering project managerial tools.

Legend: + Essential ○ Non-essential - Omitted

Curriculum Framework

Examining Employability Skills

Task Number 39

Research a principal field of interest in engineering.

Definition

Research should be made from the principal fields for specialization in engineering, including

- aerospace
- agricultural
- architectural
- bioengineering/biomedical
- chemical
- civil
- computer
- electrical
- engineering managerial
- environmental
- general
- industrial
- manufacturing
- marine/oceans
- materials
- mechanical
- mining
- naval architectural/nautical
- nuclear
- petroleum
- software
- systems.

Research should also include a comparison of academic, government, and sales/technical service careers within these fields.

Process/Skill Questions

- What does an engineer do?
- What field of specialization would you prefer to work in? Why?
- Why would a nuclear engineer require different skills/knowledge/behaviors than a software engineer?
- How do engineering careers differ in academics? In government? In sales/technical services?

ITEEA National Standards

14. Medical Technologies

15. Agricultural and Related Biotechnologies

16. Energy and Power Technologies

17. Information and Communication Technologies

18. Transportation Technologies

19. Manufacturing Technologies

20. Construction Technologies

TSA Competitive Events

Animatronics

Architectural Design

Biotechnology Design

Computer Integrated Manufacturing (CIM)

Flight Endurance

Scientific Visualization (SciVis)

Structural Design and Engineering

Video Game Design

Task Number 40

Identify educational requirements for the chosen field.

Definition

Identification should include

- job areas in engineering (e.g., mechanical, nuclear)
- college accreditation needed for each area identified
- internships
- apprenticeships
- examinations
- professional certifications required
- work experience required for licensure/certification.

Process/Skill Questions

- Why is attending an accredited college important to your career?

- How do you prepare to enter an engineering college?
- What courses would you take at the postsecondary level?
- What are the appropriate accreditations for a postsecondary school?
- What are the types of accreditation (e.g., ABET)?

ITEEA National Standards

14. Medical Technologies

15. Agricultural and Related Biotechnologies

16. Energy and Power Technologies

17. Information and Communication Technologies

18. Transportation Technologies

19. Manufacturing Technologies

20. Construction Technologies

Task Number 41

Research postsecondary education opportunities.

Definition

Research should result in identifying

- technical/trade schools
- community colleges
- four-year colleges
- job-skills training in the military
- internships
- cooperative education programs
- advanced degree programs
- available scholarships.

Process/Skill Questions

- What are engineering-related jobs that do not require four-year degrees?
- What are the requirements for your desired field?
- What are the benefits of internships?

- What student organizations have scholarships available for students focusing on engineering?

Task Number 42

Compile requirements for Professional Engineering license.

Definition

Compilation should include

- research identifying at least three engineering areas requiring licensure
- identification of required licensure examinations
- comparison of licensure requirements for the United States to those for engineers practicing outside of the United States.

Process/Skill Questions

- How do the requirements of local jurisdictions determine the licensure requirements for engineers?
- What is the legal authority of a licensed engineer?
- How do professional organizations represent licensed engineers?

Task Number 43

Develop a professional résumé.

Definition

Completed résumé should accompany a cover letter and include the following components:

- Educational background
- Work history
- Honors and awards
- Membership in club(s), professional or community associations
- Certification(s) obtained
- Leadership positions held
- Community service performed

In addition, students should identify the reasons for keeping a résumé current to reflect experience and education credentials even if they are not currently involved in a job search.

Process/Skill Questions

- What is the primary function of a résumé ?
- What are some basic résumé design and formatting requirements? What should you avoid?
- What can you do to strengthen your résumé?
- Why is it important to keep a résumé current to reflect experience and education credentials, even if you are not currently involved in a job search?

Task Number 44

Complete the job application process.

Definition

The job application process should include

- performing a job search through a variety of resources, including networking
- performing a walk-in application
- preparing for an interview.

Completed documents should include the following:

- Cover letter
- Résumé
- Letter for request of recommendation
- Letters of recommendation
- Application
- Thank-you or follow-up letter after interview

Documents should follow additional criteria specifically related to electronic transmittal of such information (e.g., attention to security concerns, inclusion of keywords to enhance interest in the application, use of scanner-friendly format).

Process/Skill Questions

- Aside from job-seeker websites, what resources can you use to help you learn the expectations and requirements of any job?
- What should you bring when applying for any job?
- What are the benefits of following up after an application or an interview?
- What is the appropriate method for presenting your application/documentation to a prospective employer?

Task Number 45

Participate in a mock interview.

Definition

Participation should give students the opportunity to practice interviewing skills prior to an actual interview. Students should assume a variety of roles to illustrate behaviors both desirable (e.g., maintaining eye contact, dressing appropriately in professional attire, asking informed questions) and undesirable (e.g., speaking too softly, failing to answer questions completely) during an interview.

Process/Skill Questions

- How can you best prepare for an interview? What resources can help you prepare?
- What behaviors should you avoid during an interview?
- From an employer's perspective, what are the objectives of conducting interviews?
- How can you improve your interviewing skills?

Task Number 46

Build a complete work portfolio.

Definition

Building the portfolio should ensure that a résumé and a combination of electronic and non-electronic documents, representative of the applicant's qualifications, are current. Selected work samples should reflect the applicant's knowledge, skills, and ability. Components should be available digitally and should include

- résumé
- cover letter
- letter(s) of request for recommendation and recommendations received
- documentation (e.g., working drawings and sketches, renderings of solid models, photos)
- certification(s) obtained
- final project proposal
- final project report
- a QR code
- self-assessment.

Process/Skill Questions

- How often should you update your portfolio?
- What samples of your work might your portfolio contain?
- Why is it important to ensure that social networking sites reflect a positive image of you?
- Why should you refrain from discussing your workplace on social networking sites?
- Why should all digital information be available online in a PDF format?
- What is a QR code, and why do you need one?

ITEEA National Standards

9. Engineering Design

Examining the Design Process

Task Number 47

Define the engineering design process.

Definition

Definition should include the following steps:

- Identify the need or opportunity for an engineering solution.
- Define an engineering design problem.
- Identify the requirements and constraints of the design problem.
- Research potential solutions to the design problem.
- Generate (brainstorm) multiple solutions to the design problem.
- Sketch the solutions to the design problem.
- Evaluate the requirements and constraints of each solution to the design problem.
- Justify an optimal solution to the design problem.
- Create a model or prototype for the chosen solution to the design problem, using appropriate materials and processes.
- Determine the objectives for an engineering test of the solution to the design problem.
- Test the solution to the design problem, using mathematical, conceptual, and/or physical modeling, simulating, and optimizing.
- Evaluate the test results.
- Formulate an alternate solution to the design problem, if needed.
- Test the alternate solution, if needed.
- Present the final project report.
- Document the final project report.

Process/Skill Questions

- Why is the engineering design process never ending?
- What is iteration?
- Why is it important to follow a design process?

ITEEA National Standards

9. Engineering Design

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Engineering Design

Task Number 48

Analyze the similarities and differences between the engineering design process and the scientific method.

Definition

Analysis should include similarities and differences in

- procedure
- order of steps
- use of process.

Process/Skill Questions

- How does a hypothesis differ from a problem/design statement?
- What is the difference between theory and application-based inquiry?
- How does the testing phase differ between the engineering design process and the scientific method?

ITEEA National Standards

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

9. Engineering Design

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Examining Intellectual Property

Task Number 49

Summarize the National Society of Professional Engineers Code of Ethics.

Definition

Summary should include the fundamental tenets of the Code:

- Hold paramount the safety, health, and welfare of the public.
- Perform services only in areas of competence.
- Issue public statements only in an objective and truthful manner.
- Act for each employer or client as faithful agents or trustees.
- Avoid deceptive acts.
- Act in an honorable, responsible, ethical, and lawful manner so as to enhance the honor, reputation, and usefulness of the profession.

Process/Skill Questions

- What are professional ethics?
- What are personal ethics?
- What is the difference between professional and personal ethics?
- What is appropriate professional dress when presenting information to a formal group?

ITEEA National Standards

4. The Cultural, Social, Economic, and Political Effects of Technology

TSA Competitive Events

Essays on Technology

Task Number 50

Identify the types of intellectual property rights and how they are protected and enforced.

Definition

Identification should include the following characteristics:

- Intellectual property is a legal concept that references creations of the mind, such as inventions, symbols, names, images, and designs used in commerce.
- Under intellectual property law, the holder of one of these abstract "properties" has certain exclusive rights to the creative work or invention.
- Engineering notebooks are used as proof of concept and ownership of intellectual property.
- Violation of these rights, typically in the form of copyright, trademark, and patent infringement, may result in legal prosecution.

Process/Skill Questions

- Why do ideas need to be protected?
- What are the potential legal consequences for plagiarism?
- What is the difference between copyright and trademark?
- Why are engineering notebooks an important part of the patent process?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

6. The Role of Society in the Development and Use of Technology

7. The Influence of Technology on History

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Digital Video Production

Engineering Design

Photographic Technology

Task Number 51

Define *patent* and its function.

Definition

Definition should include that patent is the process whereby exclusive rights are granted by a government to an inventor to manufacture, use, or sell an invention for a specific duration of time, enabling the legal protection of the invention from patent infringement.

Process/Skill Questions

- What are some historical examples of patent infringement?
- What are some examples of people credited with inventing devices that may have been invented by someone else?
- How long does a patent protect intellectual property rights?
- How do individual, collaborative, and corporate patents differ from each other?
- Why do some companies choose not to patent their products?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

6. The Role of Society in the Development and Use of Technology

7. The Influence of Technology on History

TSA Competitive Events

Engineering Design

Essays on Technology

Task Number 52

Identify the patent application process.

Definition

Identification should include key steps of the application process (made to the Director of the United States Patent and Trademark Office), such as

- a written document which comprises a specification (description and claims) and an oath or declaration
- a drawing, when necessary
- fees for filing, search, and examination.

Once a patent application is accepted, further steps are required.

Process/Skill Questions

- What resources should you use to begin a patent application?
- What document(s) can an inventor/engineer use to prove his/her claim to design?
- What government department oversees patents?
- What happens after you file/submit a patent application?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

6. The Role of Society in the Development and Use of Technology

7. The Influence of Technology on History

TSA Competitive Events

Essays on Technology

Task Number 53

Perform a patent search.

Definition

Search should follow the officially prescribed strategy:

- Brainstorm keywords related to the purpose, use, and composition of the invention.
- Look up the words in the *Index to the U.S. Patent Classification* to find potential classes/subclasses.
- Verify the relevancy of the classes/subclasses by using the Classification Schedule in the *Manual of Classification*.
- Read the classification definitions to verify the scope of the subclasses and note the references.
- Search the Issued Patents and the Published Applications databases by “Current U.S. Classification” and access full-text patents and published applications.
- Review the claims, specifications, and drawings of documents retrieved for relevancy.
- Check all references and note additional classes/subclasses to search.

Process/Skill Questions

- What are techniques for performing patent searches?
- What are the advantages of paying a third party to perform a patent search?
- How can you use the results of a patent search in the design process?
- How can you differentiate your idea from the existing patent if a similar patent is on file?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

TSA Competitive Events

Essays on Technology

Task Number 54

Identify the legal consequences of patent violation.

Definition

Identification should include legal prosecution and penalties that may result from patent violations.

Process/Skill Questions

- What are some of the legal consequences of patent violations?

- How can you prove patent violation?
- How do you defend against patent violation?
- What is the role of a patent lawyer?

ITEEA National Standards

6. The Role of Society in the Development and Use of Technology

TSA Competitive Events

Essays on Technology

Task Number 55

Explain the necessity of the marketing process.

Definition

Explanation should emphasize the basic marketing concept, which states that businesses must satisfy customers' needs and wants in order to make a profit or sustain operations.

Process/Skill Questions

- What is the marketing concept?
- How does customer orientation differ from company orientation?
- How do you determine what customers need?
- How does the marketing concept affect customer loyalty?

ITEEA National Standards

6. The Role of Society in the Development and Use of Technology

TSA Competitive Events

Engineering Design

Task Number 56

Evaluate safety of designs.

Definition

Evaluation should be based upon the following criteria:

- Does the design create the safest product within constraints?
- Does the design adhere to industry/legal safety standards?
- Has the design been tested?
- Has the design minimized the risk to the end user (i.e., consumer) and artisan (i.e., manufacturer)?

Process/Skill Questions

- What is a constraint that may affect product safety?
- Why are product safety standards sometimes compromised by industry?
- How do product safety standards affect design?
- Why are engineers required to predict potential misuses of products?
- What methods are used to balance feasibility of manufacturing and employee/customer safety?

ITEEA National Standards

12. Use and Maintain Technological Products and Systems

13. Assess the Impact of Products and Systems

TSA Competitive Events

Dragster Design

Transportation Modeling

Task Number 57

Compare professional and personal ethics.

Definition

Comparison should include

- professional ethics—rules of conduct required or understood as a part of a particular workplace and profession
- personal ethics—rules of conduct one freely subscribes to without being required to do so by an external moral authority (e.g., workplace, profession, religion, social club).

Process/Skill Questions

- What is the difference between morality and ethics?
- How do personal ethics affect professional ethics?
- How can an engineer resolve a conflict between his or her personal and professional ethics?

ITEEA National Standards

4. The Cultural, Social, Economic, and Political Effects of Technology

TSA Competitive Events

Digital Video Production

Essays on Technology

Extemporaneous Speech

Geospatial Technology (Virginia only)

Photographic Technology

Video Game Design

Webmaster

Task Number 58

Identify ethical theories (i.e., utilitarianism, duty, rights, virtue).

Definition

Identification should include the following:

- Utilitarianism—concerned with the happiness or well-being of the greatest number in any group
- Duty—concerned with acting out of expectations and performed out of a sense of obligation to family, profession, country
- Rights—concerned with the protection of the happiness and well-being of the individual over that of any group
- Virtue—concerned with helping people develop good character traits, such as kindness and generosity, and placing less emphasis on which rules people should follow

Process/Skill Questions

- What are some negative outcomes associated with ethical theories?
- When do duty ethics and rights ethics come into conflict?
- What are the most important ethical dilemmas facing American businesses today?
- How do culture and geography affect ethics?

ITEEA National Standards

4. The Cultural, Social, Economic, and Political Effects of Technology

TSA Competitive Events

Digital Video Production

Essays on Technology

Extemporaneous Speech

Geospatial Technology (Virginia only)

Photographic Technology

Video Game Design

Webmaster

Designing a Practicum Project

Task Number 59

Write an engineering technical report for your engineering practicum.

Definition

Report should be based on visualization, conceptualization, imagination, innovation, and creativity and

- state the problem and solution
- produce a cost analysis of the process
- justify the appropriateness of solution
- describe the plausibility of solution
- address the solution's marketability.

Process/Skill Questions

- What elements are required in a basic proposal?
- What is technical writing?
- Why is it crucial to know the audience/decision makers?
- What are the essential components to a properly developed engineering technical report?

ITEEA National Standards

12. Use and Maintain Technological Products and Systems

13. Assess the Impact of Products and Systems

TSA Competitive Events

Engineering Design

System Control Technology

Task Number 60

Present a proposal to an engineering challenge.

Definition

The presentation should use multimedia elements and include

- an introduction, thorough presentation of points, and a conclusion
- a persuasive tone and strategy
- a realistic/practical approach to the solution
- a display of proficient communications skills, professional demeanor, and confidence.

Process/Skill Questions

- What are the benefits of presentations that use clear structure and language?
- What are the drawbacks of using too many multimedia elements ("bells and whistles") in any presentation?
- What is the importance of having a deep familiarity with and understanding of subject matter?

ITEEA National Standards

12. Use and Maintain Technological Products and Systems

13. Assess the Impact of Products and Systems

TSA Competitive Events

Architectural Design

Computer Integrated Manufacturing (CIM)

Digital Video Production

Engineering Design

Prepared Presentation

System Control Technology

Task Number 61

Peer review all proposals.

Definition

Peer reviews should include positive and constructive feedback for the presenter on

- verbal and presentation skills
- nonverbal actions
- clarity of the presentation.

Process/Skill Questions

- Why is peer feedback needed?
- What are benefits of peer feedback vs. teacher (mentor) feedback?
- What defines *constructive feedback*?

Task Number 62

Identify the need or opportunity for an engineering solution.

Definition

Identification should include

- a problem that needs to be solved
- the way the solution extends human potential
- the appropriateness of the solution
- the viability of the project.

Process/Skill Questions

- What is an example of an engineering problem? A local engineering problem?
- What are some examples of products or situations that could benefit from re-engineering?
- What are some engineering solutions that have extended human potential?
- Why would a design team choose to conduct a market survey?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Process

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

Architectural Design

Computer Integrated Manufacturing (CIM)

Dragster Design

Engineering Design

Flight Endurance

System Control Technology

Transportation Modeling

Video Game Design

Task Number 63

Define a design problem.

Definition

Definition should include a design brief (i.e., a statement that explains what the solution must accomplish).

Process/Skill Questions

- What is a design brief?
- What are the most important elements of a design brief?
- Why is it important to have a clear definition of the problem before attempting to solve it?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Process

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

Architectural Design

Computer Integrated Manufacturing (CIM)

Dragster Design

Engineering Design

Flight Endurance

System Control Technology

Transportation Modeling

Video Game Design

Task Number 64

Identify the constraints of a design problem.

Definition

Identification should include the specification and criteria of the problem (i.e., what the design must do to be considered a success and what resources are available).

Process/Skill Questions

- What are available resources?
- Why is all design performed under constraints?
- What is the difference between a specification and a criterion?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Process

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

Architectural Design

Computer Integrated Manufacturing (CIM)

Dragster Design

Engineering Design

Flight Endurance

System Control Technology

Transportation Modeling

Video Game Design

Task Number 65

Research potential solutions for a design problem.

Definition

Research through library, Internet, and other sources should include

- examples of current solutions
- criticism
- proper citation or documentation, when required.

Process/Skill Questions

- How do you identify quality sources?
- What are the dangers of using the Internet as your solitary source?
- Why is it important to use multiple sources?
- What are the benefits of using multiple media sources for research?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Process

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

Architectural Design

Computer Integrated Manufacturing (CIM)

Dragster Design

Engineering Design

Flight Endurance

System Control Technology

Transportation Modeling

Video Game Design

Task Number 66

Generate new (i.e., original) solutions for the design problem.

Definition

Process should include at least three solutions and may include

- sketches
- lists
- multimedia elements
- flowcharts.

Process/Skill Questions

- What are the benefits of generating multiple solutions?
- What is brainstorming, and what are its steps?
- How do sketches aid the brainstorming process?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Process

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

Architectural Design

Computer Integrated Manufacturing (CIM)

Dragster Design

Engineering Design

Flight Endurance

System Control Technology

Transportation Modeling

Video Game Design

Task Number 67

Evaluate potential solutions.

Definition

Potential solutions should be evaluated for feasibility, including evaluation of

- necessary research and development

- capital required
- labor required to produce
- utilities required
- power/water required
- waste discharged
- hazardous materials involved, if applicable
- exhaust emitted
- market need/capacity
- cost vs. benefit
- time to market
- potential competition.

Process/Skill Questions

- How does the feasibility study affect the decision-making process for producing the solution?
- Will the benefits outweigh the costs?
- How is green engineering accounted for in this process?

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Dragster Design

Engineering Design

Flight Endurance

System Control Technology

Video Game Design

Task Number 68

Sketch/diagram solutions for a design problem.

Definition

Sketches may be

- freehand
- isometric

- orthographic/multi-view
- computer-aided/generated.

Process/Skill Questions

- What are some examples of sketches?
- What are some examples of orthographic multi-views?
- What are some examples of computer-aided sketches?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Process

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

Architectural Design

Dragster Design

Engineering Design

Flight Endurance

System Control Technology

Transportation Modeling

Video Game Design

Task Number 69

Identify potential risks involved with the solution(s).

Definition

Identification should include potential risks, concerns, or issues regarding what may not go as planned, as well as possible contingency plans.

Process/Skill Questions

- What are some common risks or concerns associated with solutions?
- What are the steps in identifying possible contingency plans?

ITEEA National Standards

4. The Cultural, Social, Economic, and Political Effects of Technology

TSA Competitive Events

Engineering Design

Task Number 70

Research model-driven engineering.

Definition

Research should include

- model types
- key components
- uses for each model type.

Process/Skill Questions

- What is the definition of *model-driven engineering*?
- What factors contribute to model selection?
- What constraints should you consider when selecting a model type?
- How do you determine which model type will produce the most robust solution?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Process

13. Assess the Impact of Products and Systems

9. Engineering Design

TSA Competitive Events

Dragster Design

Engineering Design

Transportation Modeling

Task Number 71

Create a model for the technological problem.

Definition

Model should be created by identifying goals and various constraints of the technological problem, and by using one or more of the three model types:

- Physical
- Conceptual
- Mathematical

Process/Skill Questions

- How do you create a mathematical model from the techniques available?
- What factors spark your interest in working on solutions to technological problems?
- What factors motivate organizations to focus their attention on specific technological projects?
- What is the purpose of creating models?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Process

9. Engineering Design

TSA Competitive Events

Animatronics

Architectural Design

Biotechnology Design

Computer Integrated Manufacturing (CIM)

Computer-Aided Design (CAD), Architecture

Computer-Aided Design (CAD), Engineering

Dragster Design

Engineering Design

Flight Endurance

Geospatial Technology (Virginia only)

Scientific Visualization (SciVis)

Structural Design and Engineering

System Control Technology

Transportation Modeling

Video Game Design

Task Number 72

Test the model's effectiveness in solving the design problem.

Definition

Test should evaluate the results, based on the following criteria:

- Is the solution repeatable?

- Is the solution consistent?
- Is the solution reliable?
- Is the solution valid?

Process/Skill Questions

- How do the model's results compare to real-world results?
- What types of errors could results produce?
- What factors contribute to errors in modeling?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Process

13. Assess the Impact of Products and Systems

9. Engineering Design

TSA Competitive Events

Animatronics

Computer Integrated Manufacturing (CIM)

Engineering Design

Flight Endurance

Geospatial Technology (Virginia only)

System Control Technology

Technology Problem Solving

Video Game Design

Task Number 73

Evaluate potential solutions to a design problem.

Definition

Evaluation should include pros and cons of each identified solution (e.g., cost, duration of construction/project, impacts of the solution, plausibility, ethics).

Process/Skill Questions

- Why is it important to identify the “cons” of potential solutions before attempting to implement a solution?
- How might your solution affect the environment?
- Why is it important to consider the ethics of the potential solution?
- Why is it important to identify unintentional impacts of a potential solution?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Process

4. The Cultural, Social, Economic, and Political Effects of Technology

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

Architectural Design

Computer Integrated Manufacturing (CIM)

Dragster Design

Engineering Design

Flight Endurance

System Control Technology

Transportation Modeling

Video Game Design

Task Number 74

Analyze potential risk list.

Definition

Analysis should include reviewing the potential risk list, identifying which risks, if any, occurred, and describing a plan for modifications.

Process/Skill Questions

- How does a contingency plan help with progress?
- What are logistics?
- Why is documentation important throughout the entire design process?

ITEEA National Standards

9. Engineering Design

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Dragster Design

Engineering Design

Flight Endurance

System Control Technology

Task Number 75

Choose the optimal solution to a design problem based on constraints and original identified solutions.

Definition

Choice should be determined by

- cost
- duration of construction/project
- impacts of the solution
- plausibility
- ethics.

Process/Skill Questions

- What are trade-offs?
- How do trade-offs affect the decision-making process?
- What is the definition of *optimal solution*?
- Why is a decision matrix important during the decision-making process?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Process

4. The Cultural, Social, Economic, and Political Effects of Technology

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

Architectural Design

Computer Integrated Manufacturing (CIM)

Dragster Design

Engineering Design

Flight Endurance

System Control Technology

Transportation Modeling

Video Game Design

Task Number 76

Develop a budget.

Definition

Budget should include forecasted expenses and a plan for income.

Process/Skill Questions

- What is the importance of a budget?
- What software can be used for budget development?
- What is the impact of not developing a budget?
- How can you obtain income to fund the development of a project?

ITEEA National Standards

4. The Cultural, Social, Economic, and Political Effects of Technology

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Engineering Design

Task Number 77

Create a work schedule.

Definition

Work schedule should include

- prioritized tasks
- resource allocation
- timeline for task completion.

Process/Skill Questions

- Why is it important to prioritize tasks?

- What is a Gantt chart?
- Why are work schedules necessary?

ITEEA National Standards

9. Engineering Design

TSA Competitive Events

Animatronics

Architectural Design

Biotechnology Design

Computer Integrated Manufacturing (CIM)

Computer-Aided Design (CAD), Architecture

Computer-Aided Design (CAD), Engineering

Dragster Design

Engineering Design

Flight Endurance

Geospatial Technology (Virginia only)

Scientific Visualization (SciVis)

Structural Design and Engineering

System Control Technology

Transportation Modeling

Video Game Design

Task Number 78

Implement the solution to the design problem.

Definition

Implementation for products may include

- modeling
- prototyping
- drawings
- 3-D renderings.

Implementation for processes may include

- steps
- constraints
- resources.

Process/Skill Questions

- What is the definition of *prototype*?
- What are different methods of modeling?
- What changes were made following the initial modeling stage?
- Why are prototypes important to the process?
- How does a solution move from paper (i.e., conception) to final product?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Process

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

Architectural Design

Computer Integrated Manufacturing (CIM)

Dragster Design

Engineering Design

Flight Endurance

System Control Technology

Transportation Modeling

Video Game Design

Task Number 79

Communicate solution to stakeholders.

Definition

Communication techniques should include

- speaking skills/body language
- technical writing and memos/emails
- visual aids and multimedia use
- professionalism/etiquette
- enthusiasm/persuasiveness.

Stakeholders should include

- community leaders
- organizations
- development teams/personnel
- management
- investors
- government
- clients.

Process/Skill Questions

- Why should you include stakeholders in decision making?
- How often should stakeholders receive communication throughout the process?
- How do you persuasively communicate the solution to your stakeholders?
- What courses can you take to make yourself a better speaker?
- How does a stakeholder's background affect your choice of communication technique?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Process

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

Architectural Design

Computer Integrated Manufacturing (CIM)

Dragster Design

Engineering Design

Flight Endurance

System Control Technology

Transportation Modeling

Video Game Design

Task Number 80

Test the solution.

Definition

Process should include using a validated testing mechanism to verify that the design meets project requirements.

Process/Skill Questions

- How do you safely test your solution?
- How do you know that the design meets the project requirements?
- How do you determine which test you should use?
- How do you determine the validity of a test?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Process

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

Architectural Design

Computer Integrated Manufacturing (CIM)

Dragster Design

Engineering Design

Flight Endurance

System Control Technology

Transportation Modeling

Video Game Design

Task Number 81

Evaluate test results.

Definition

Evaluation should include

- consideration of costs, scale, resources, time of project, and solution
- determination of the degree to which the solution meets the original objective
- examination of constraints
- interpretation of data
- validation of data.

Process/Skill Questions

- How do you determine the cost-effectiveness of your solution?
- What are the factors affecting cost?
- What is the difference between efficiency and effectiveness?
- How do you validate your data/results?
- How is design determined by constraints?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Process

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

Architectural Design

Computer Integrated Manufacturing (CIM)

Dragster Design

Engineering Design

Flight Endurance

System Control Technology

Transportation Modeling

Video Game Design

Task Number 82

Improve the solution.

Definition

Improvement should be made by

- reviewing and modifying brainstorm input during the design process
- using informative feedback from the solution
- reviewing the engineering journal.

Process/Skill Questions

- What is quality or effective feedback?
- How often should the process or product be reviewed?
- Why are successful engineers never satisfied with the final product or process?
- What are some measurement tools for quality control?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Process

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

Architectural Design

Computer Integrated Manufacturing (CIM)

Dragster Design

Engineering Design

Flight Endurance

System Control Technology

Transportation Modeling

Video Game Design

Task Number 83

Deliver a final project presentation.

Definition

Presentation may include

- problem statement
- obstacles and solutions in process
- graphical representations and visual aids (e.g., diagrams, sketches, photos, videos)
- solution steps
- methods used to improve cost-effectiveness
- evaluation of solution
- final results, based on initial expectations and meeting the requirements of the proposal.

Process/Skill Questions

- What are the benefits of presenting graphical/visual representations of your solution?
- What makes a presentation effective and persuasive?
- How can a good/poor presentation affect the audience's acceptance of your solution?

ITEEA National Standards

11. Apply the Design Process

12. Use and Maintain Technological Products and Systems

TSA Competitive Events

Architectural Design

Digital Video Production

Dragster Design

Prepared Presentation

Technology Problem Solving

Video Game Design

Task Number 84

Document a final project report.

Definition

Documentation should include

- abstract
- introduction
- research questions and/or hypothesis
- methods and materials
- results
- conclusions
- appendices (e.g., raw data, sketches, notes, surveys)
- references and works cited.

Process/Skill Questions

- What elements belong in a technical report?
- What is the purpose of an abstract?
- Why should you include appendices in the report?
- What were the metrics involved in the design of the solution?

ITEEA National Standards

11. Apply the Design Process

12. Use and Maintain Technological Products and Systems

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Essays on Technology

Flight Endurance

Prepared Presentation

Task Number 85

Develop a schedule using industry-standard software applications to ensure the solution can be completed during the course.

Definition

Management schedule should include

- estimated time for daily activities
- a work breakdown schedule (WBS)
- a list of task dependencies.

Process/Skill Questions

- What are the benefits of using a management schedule in the field of engineering?
- What are task dependencies?
- How can a management schedule help allocate resources?

ITEEA National Standards

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

TSA Competitive Events

Animatronics

Architectural Design

Biotechnology Design

Computer Integrated Manufacturing (CIM)

Computer-Aided Design (CAD), Architecture

Computer-Aided Design (CAD), Engineering

Dragster Design

Engineering Design

Flight Endurance

Geospatial Technology (Virginia only)

Scientific Visualization (SciVis)

Structural Design and Engineering

System Control Technology

Transportation Modeling

Video Game Design

Task Number 86

Research cost-estimation tools and methods in the engineering field.

Definition

Research should include

- choice of alternate materials
- calculation of area and volume
- cost estimation of large-volume production.

Process/Skill Questions

- What are some common cost-estimation tools and methods in the engineering field?
- Why is cost estimation important in the engineering field?

ITEEA National Standards

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

TSA Competitive Events

Animatronics

Architectural Design

Biotechnology Design

Computer Integrated Manufacturing (CIM)

Dragster Design

Engineering Design

Flight Endurance

Structural Design and Engineering

System Control Technology

Transportation Modeling

Video Game Design

Task Number 87

Develop an engineering journal to compile important information.

Definition

Engineering journals should include

- sketches
- ideas
- daily work summaries
- printouts
- calculations.

Process/Skill Questions

- What is the purpose of an engineering journal?
- What significance does an engineering journal have in the patent process?
- Why must entries be signed and dated?

ITEEA National Standards

9. Engineering Design

TSA Competitive Events

Animatronics

Architectural Design

Biotechnology Design

Computer Integrated Manufacturing (CIM)

Computer-Aided Design (CAD), Architecture

Computer-Aided Design (CAD), Engineering

Dragster Design

Engineering Design

Flight Endurance

Geospatial Technology (Virginia only)

Scientific Visualization (SciVis)

Structural Design and Engineering

System Control Technology

Transportation Modeling

Video Game Design

Task Number 88

Control engineering project managerial tools.

Definition

Managerial tools should include

- project plan determining the proper sequence of activities

- Gantt charts
- program logic model predicting project outcomes.

Process/Skill Questions

- What problem/opportunity does the project address?
- What results are to be achieved?
- How will success be measured?
- How will you know when you are finished?

ITEEA National Standards

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

TSA Competitive Events

Animatronics

Architectural Design

Biotechnology Design

Computer Integrated Manufacturing (CIM)

Dragster Design

Engineering Design

Flight Endurance

Scientific Visualization (SciVis)

Structural Design and Engineering

System Control Technology

Transportation Modeling

SOL Correlation by Task

39	Research a principal field of interest in engineering.	English: 11.8, 12.8 Science: PH.3
40	Identify educational requirements for the chosen field.	English: 11.5, 12.5
41	Research postsecondary education opportunities.	English: 11.5, 11.8, 12.5, 12.8 History and Social Science: GOVT.7, GOVT.8, GOVT.9
42	Compile requirements for Professional Engineering license.	English: 11.5, 11.8, 12.5
43	Develop a professional résumé.	English: 11.6, 11.7, 12.6, 12.7
44	Complete the job application process.	English: 11.6, 11.7, 12.6, 12.7
45	Participate in a mock interview.	English: 11.1, 12.1
46	Build a complete work portfolio.	English: 11.1, 12.1
47	Define the engineering design process.	English: 11.3, 11.5, 11.8, 12.3, 12.5, 12.8 Mathematics: AII.3, AII.7, AII.9, COM.1, COM.2, COM.3, COM.4, COM.7, COM.8, COM.9, COM.10, COM.11, COM.13, COM.14, COM.15, COM.17, COM.18, MA.1, MA.2, MA.7, MA.8, PS.1*, PS.2*, PS.3*, PS.4*, PS.7*, PS.8*, PS.10* Science: PH.1
48	Analyze the similarities and differences between the engineering design process and the scientific method.	English: 11.5, 12.5 History and Social Science: WHII.4 Science: CH.1, PH.1
49	Summarize the National Society of Professional Engineers Code of Ethics.	English: 11.5, 12.5
50	Identify the types of intellectual property rights and how they are protected and enforced.	English: 11.5, 12.5 History and Social Science: GOVT.1, GOVT.9, GOVT.15
51	Define <i>patent</i> and its function.	English: 11.3, 12.3 History and Social Science: GOVT.1, GOVT.9, GOVT.15
52	Identify the patent application process.	English: 11.5, 12.5 History and Social Science: GOVT.1, GOVT.9, GOVT.15

53	Perform a patent search.	English: 11.5, 11.8, 12.5, 12.8 History and Social Science: GOVT.1, GOVT.9, GOVT.15
54	Identify the legal consequences of patent violation.	English: 11.5, 12.5 History and Social Science: GOVT.1, GOVT.9, GOVT.15
55	Explain the necessity of the marketing process.	English: 11.5, 12.5
56	Evaluate safety of designs.	English: 11.5, 12.5 Science: PH.3
57	Compare professional and personal ethics.	English: 11.5, 12.5 History and Social Science: GOVT.1, GOVT.16
58	Identify ethical theories (i.e., utilitarianism, duty, rights, virtue).	English: 11.5, 12.5 History and Social Science: GOVT.1, GOVT.16
59	Write an engineering technical report for your engineering practicum.	English: 11.6, 11.7, 12.6, 12.7
60	Present a proposal to an engineering challenge.	English: 11.1, 12.1
61	Peer review all proposals.	English: 11.1, 12.1
62	Identify the need or opportunity for an engineering solution.	English: 11.5, 12.5 History and Social Science: GOVT.1, GOVT.16 Science: PH.1, PH.4
63	Define a design problem.	English: 11.6, 11.7, 12.6, 12.7 History and Social Science: GOVT.1 Mathematics: COM.2, COM.3 Science: PH.1
64	Identify the constraints of a design problem.	English: 11.5, 12.5 Mathematics: COM.2, COM.3 Science: PH.1
65	Research potential solutions for a design problem.	English: 11.8, 12.8 History and Social Science: GOVT.1

		Science: PH.4
66	Generate new (i.e., original) solutions for the design problem.	English: 11.5, 12.5 History and Social Science: GOVT.1 Science: PH.1
67	Evaluate potential solutions.	English: 11.5, 12.5 History and Social Science: GOVT.1 Science: PH.1
68	Sketch/diagram solutions for a design problem.	Mathematics: COM.12 Science: PH.1, PH.4
69	Identify potential risks involved with the solution(s).	English: 11.5, 12.5
70	Research model-driven engineering.	English: 11.8, 12.8 History and Social Science: GOVT.1
71	Create a model for the technological problem.	English: 11.5, 12.5 Mathematics: AII.3, AII.7, COM.1, COM.2, COM.3, COM.4, COM.7, COM.8, COM.9, COM.10, COM.11, COM.13, COM.14, COM.15, COM.17, COM.18, MA.1, MA.2, MA.7
72	Test the model's effectiveness in solving the design problem.	English: 11.5, 12.5 History and Social Science: GOVT.1
73	Evaluate potential solutions to a design problem.	English: 11.5, 12.5
74	Analyze potential risk list.	English: 11.5, 12.5
75	Choose the optimal solution to a design problem based on constraints and original identified solutions.	English: 11.5, 12.5
76	Develop a budget.	History and Social Science: GOVT.1, GOVT.15
77	Create a work schedule.	English: 11.1, 12.1
78	Implement the solution to the design problem.	Mathematics: AII.3, AII.7, COM.1, COM.2, COM.3, COM.4, COM.7, COM.8, COM.9, COM.10, COM.11, COM.13, COM.14, COM.15, COM.17, COM.18, MA.1, MA.2, MA.7
79	Communicate solution to stakeholders.	English: 11.1, 12.1
80	Test the solution.	English: 11.5, 12.5 Mathematics: PS.19, PS.8*, PS.10*

81	Evaluate test results.	English: 11.5, 12.5
82	Improve the solution.	
83	Deliver a final project presentation.	English: 11.1, 12.1
84	Document a final project report.	English: 11.6, 11.7, 11.8, 12.6, 12.7, 12.8
85	Develop a schedule using industry-standard software applications to ensure the solution can be completed during the course.	English: 11.1, 12.1
86	Research cost-estimation tools and methods in the engineering field.	English: 11.8, 12.8
87	Develop an engineering journal to compile important information.	English: 11.1, 11.6, 11.7, 12.1, 12.6, 12.7
88	Control engineering project managerial tools.	

Entrepreneurship Infusion Units

Entrepreneurship Infusion Units may be used to help students achieve additional, focused competencies and enhance the validated tasks/competencies related to identifying and starting a new business venture. Because the unit is a complement to certain designated courses and is not mandatory, all tasks/competencies are marked “optional.”

Appendix: Credentials, Course Sequences, and Career Cluster Information

Industry Credentials: Only apply to 36-week courses

- College and Work Readiness Assessment (CWRA+)
- Design and Pre-Construction Assessment
- Engineering Technology Examination
- National Career Readiness Certificate Assessment
- Pre-Engineering Certification Examinations
- Pre-Engineering/Engineering Technology Assessment
- Stratasys Additive Manufacturing Certification – Level 1 Examination
- Workplace Readiness Skills for the Commonwealth Examination

Concentration sequences: *A combination of this course and those below, equivalent to two 36-week courses, is a concentration sequence. Students wishing to complete a specialization may take additional courses based on their career pathways. A program completer is a student who has met the requirements for a CTE concentration sequence and all other requirements for high school graduation or an approved alternative education program.*

- Biomedical Engineering (8467/36 weeks)
- Engineering Analysis and Applications II (8451/36 weeks)
- Engineering Concepts and Processes III (8452/36 weeks)
- Engineering Design and Development (PLTW) (8443/36 weeks)
- Engineering Explorations I (8450/36 weeks)
- Engineering Studies (8491/36 weeks)
- Principles of Engineering (PLTW) (8441/36 weeks)

Career Cluster: Science, Technology, Engineering and Mathematics	
Pathway	Occupations
Engineering and Technology	Aerospace Engineer Biomedical Engineer Civil Engineer Computer Hardware Engineer Electrical Engineer Industrial Engineer Manufacturing Systems Engineer Materials Engineer Mechanical Engineer Nuclear Engineer Statistician