south dakota
DEPARTMENT OF EDUCATION
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CTE Standards Unpacking
Introduction to Engineering

Course: Introduction to Engineering
Course Description: The Introduction to Engineering course is designed to provide a foundation in engineering for students in South Dakota. Students are engaged in an instructional program that integrates academics and technical preparation and focuses on career awareness and ethics in engineering. This course will prepare students for advanced educational opportunities. Topics addressed in Introduction to Engineering include: exploring the field of engineering, understanding materials and processes used in engineering, investigating systems used in engineering and practicing effective communication.
Career Cluster: STEM
Prerequisites: None
Program of Study Application: This is a pathway course in the STEM cluster Engineering pathway. It is recommended that the course be preceded by a series of foundation courses and a cluster course in STEM, and followed by a more specialized pathway course such as Industrial and Bioprocess Engineering, Mechanical Drafting & Design or Architectural Drafting.

<table>
<tr><td colspan="3">INDICATOR #IE 1: Examine the fields of engineering</td></tr>
<tr><td colspan="3">SUB-INDICATOR 1.1 (Webb Level: 3 Strategic Thinking): Examine the evolution of engineering</td></tr>
<tr><td colspan="3">SUB-INDICATOR 1.2 (Webb Level: 1 Recall): Identify the types of engineers</td></tr>
<tr><td colspan="3">SUB-INDICATOR 1.3 (Webb Level: 1 Recall): Describe the engineering team</td></tr>
<tr><td>Knowledge (Factual):
History of engineering

Evolution of engineering

Fields of engineering and job description of an engineer in various fields.

The roles and functions of engineering team.</td><td>Understand (Conceptual):
Engineering is a diverse field with many specialties.

Because of engineering specialties, engineers will often work together in teams.</td><td>Skills (Application):
Assess the influence of engineering on history

Differentiate the various fields of engineering and the job functions/roles of each.

Formulate a timeline of major engineering development</td></tr>
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Benchmarks

Students will be assessed on their *ability* to:

- Define a job description of an engineer.
- Identify the work tasks, duties, and responsibilities of different types of engineers
  Identify various branches of engineering
- Identify work setting/environments of engineering teams
- Explain how engineers can combine their specific specialties to accomplish a complex task.

Academic Connections

ELA Literacy and/or Math Standard (if applicable, Science and/or Social Studies Standard):	**Sample Performance Task Aligned to the Academic Standard(s):**
11-12.W.2. Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.	Research and prepare a report about the different types of engineers and their job duties.

INDICATOR #IE 2: **Investigate various engineering systems**

SUB-INDICATOR 2.1 (Webb Level: 1 Recall): Identify various types of engineering systems

SUB-INDICATOR 2.2 (Webb Level: 2 Skills/Concepts): Apply engineering systems to solve problems

Knowledge (Factual):	**Understand (Conceptual):**	**Skills (Application):**
Engineering systems Components of engineering systems	Understand components of engineering systems Solve problems using engineering systems	Construct circuits from a schematic diagram Construct a mechanical system from visual or written instructions

		Construct/modify a device to control the temperature in an enclosure

Benchmarks
Students will be assessed on their *ability* to:

- Define each engineering system and give an example for each
- Match engineering systems to common processes
- List the components of an engineering system

Academic Connections	
ELA Literacy and/or Math Standard (if applicable, Science and/or Social Studies Standard): 9-12-ETS1-2.Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.	**Sample Performance Task Aligned to the Academic Standard(s):** Identify a problem that can be solved using the engineering practices. Design a research based solution. Communicate justification for the solution while recognizing potential limitations and constraints

INDICATOR #IE 3: **Apply the engineering process to a product**		
SUB-INDICATOR 3.1 (Webb Level: 2 Skill/Concept): Design a product		
SUB-INDICATOR 3.2 (Webb Level: 2 Skill/Concept): Construct a three-dimensional (3-D) model		
SUB-INDICATOR 3.3 (Webb Level: 2 and 3): Build and test a prototype		
SUB-INDICATOR 3.4 (Webb Level: 2 and 4): Develop a system to produce a final product		
Knowledge (Factual): Engineering Design Process Reliable sources of information.	**Understand (Conceptual):** The design solution may require multiple revisions and modifications as it is tested.	**Skills (Application):** Graph and interpret thumbnail sketches to create ideas Modify a three view

Engineering is a practice used to solve a problem.	Problem solving skills, perseverance and the ability to analyze data, ask questions and think critically are essential skills.	orthographic projection of a design Construct a design of a doghouse using computer-aided design (CAD) Construct a product based upon specification and build a prototype. Apply the design process to engineering design process.

Benchmarks

Students will be assessed on their *ability* to:

- Revise and use the prototype in real-world conditions
- Assess a feasibility study on the prototype
- Draw conclusions from data generated from testing the prototype
- Organize and construct an assembly line that would effectively and efficiently produce a final product
- Create a process that would allow for product development
- Create and design a flowchart demonstrating the product development process

Academic Connections

ELA Literacy and/or Math Standard (if applicable, Science and/or Social Studies Standard):	**Sample Performance Task Aligned to the Academic Standard(s):**
7.ET.CT.2 Students demonstrate the design process through problem solving.	Apply a selected design process as directed by the teacher.
9-12 ET.CT.2 Students demonstrate the design process through problem solving.	Compare and contrast methods for problem-solving and decision-making.
CCSS.MATH.PRACTICE.MP1 Make sense	Formulate a technological solution using

of problems and persevere in solving them. CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. 9-12.ET.CI.1.1 Investigate and apply simulations with real-world situations.	data-driven decision making Create a set of inquiry and teambuilding labs
Science and Engineering Practices · Asking Questions and Defining · Problems Developing and Using Models · Planning and Carrying out Investigations · Constructing Explanations and Designing Solutions · Obtaining, Evaluating, and Communicating Information	**Science and Engineering Practices** Be explicit with students about the Science and Engineering Practices involved in designing and testing a solution to a problem. Have students reflect on which practices they used.
Engineering and Design Standards 9-12-ETS1-2.Design a solution to a complex real-world problem by breaking it down into smaller, more managable problems that can be solved through engineering.	**Engineering and Design Standards** Design a research based solution. Carry out tests to assess the effectiveness of the solution. Document modifications and subsequent trials that are conducted.

INDICATOR #IE 4: **Demonstrate effective communication**		
SUB-INDICATOR 4.1 (Webb Level: 2 and 3): Demonstrate effective oral communication		
SUB-INDICATOR 4.2 (Webb Level: 3 and 4): Demonstrate effective written communication		
SUB-INDICATOR 4.3 (Webb Level: 4 Extended Thinking): Demonstrate effective graphic communication		
Knowledge (Factual):	**Understand (Conceptual):**	**Skills (Application):**

Effective oral communication Effective written communication Effective graphic communication	The importance of effective oral, written, and graphic communication Engineering and Design process involves regular communication with peers, the public and funding agencies to name a few. Communication both in writing and verbally (public speaking) is an essential part of the engineering and design process.	Organize and present a speech that addresses environmental issues related to engineering Develop a logical argument and a solution to solve a problem Cite evidence of the importance of each step in the engineering design process through an oral presentation Formulate a report summarizing how an engineering system works Create a set of directions to assemble a product Design a newspaper editorial and prove your view on a controversial engineering issue Design and present an idea for a product to the class using software application of choice Design and connect concepts learned using publishing software and graphic programs
Benchmarks		

Students will be assessed on their *ability* to:

- Design final product options to meet client demand based on needs and responses
- Demonstrate effective oral communication by creating a presentation of the final product for potential clients
- Demonstrate effective written communication by creating a report for potential clients
- Demonstrate effective graphic communication by creating a chart or graph to represent ideas to a potential client.

Academic Connections

ELA Literacy and/or Math Standard (if applicable, Science and/or Social Studies Standard):	**Sample Performance Task Aligned to the Academic Standard(s):**
ET.CI.1 Students use technology to generate ideas and promote creativity. ELA - 11-12.W.4 -Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. 11-12.W.2. Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.	Investigate and apply simulations with real-world situations. Utilize a virtual learning environment as a strategy to build technology literacy skills. Utilize technology for collaboration, research, publication, communication and productivity.

INDICATOR #IE 5: **Examine testing procedures used on materials in engineering**

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SUB-INDICATOR 5.1 (Webb Level: 3 Strategic Thinking): Analyze materials based on their properties		
SUB-INDICATOR 5.2 (Webb Level: 3 Strategic Thinking): Analyze material testing procedures		
Knowledge (Factual): Properties of materials Procedures for testing materials	**Understand (Conceptual):** That materials have different properties that can be manipulated to fit a given situation. That many different materials can be used to solve engineering problems.	**Skills (Application):** Compare and contrast materials used in engineering Assess availability and cost of materials Investigate the physical factors of the material(s) Compare the cost factor(s) for various testing processes Draw conclusions from the Brinell Hardness test on materials

Benchmarks

Students will be assessed on their *ability* to:

- Identify the physical factors of the material(s) used in engineering design.
- Understand the cost factor(s) for using various materials in the design process.

Academic Connections	
ELA Literacy and/or Math Standard	**Sample Performance Task Aligned to**

(if applicable, Science and/or Social Studies Standard): 9-12-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. CCSS.MATH.PRACTICE.MP4 Model with mathematics.	**the Academic Standard(s):** Compare and contrast the materials used in the engineering design process and present information using mathematical equations to convey information.

Additional Resources
Please list any resources (e.g., websites, teaching guides, etc.) that would help teachers as they plan to teach these new standards.

Brinell Hardness Test Methods - www.hardnesstesters.com › Applications

National Society of Professional Engineers – https:// www.**nspe**.org

Disciplinary Core Ideas for Science Education
http://doe.sd.gov/contentstandards/documents/ApxA-DCIP.pdf

Science and Engineering Practices and Cross Cutting Concepts

http://doe.sd.gov/contentstandards/documents/ApxB-SEPc.pdf

Engineering Design Standards
http://doe.sd.gov/contentstandards/documents/ApxCengin.pdf

Engineering and Design Process
https://www.teachengineering.org/k12engineering/designprocess

Engineering and Design Process Template for Students
http://www.crscience.org/pdf/EngineeringGraphics.pdf

Engineering Design Rubric
https://drive.google.com/file/d/0B23HYd76LsIVb3k5Z1kwckdLYnM/view?usp=sharing

Best Robotics
https://www.sdstate.edu/engr/camps/best-robotics/index.cfm

Electrical Engineering Camp
https://www.sdstate.edu/eecs/camps/index3.cfm