Engineering Fundamentals

Period 6 (2:05–3:15) • Mondays, Wednesdays, and Fridays • 2023-2024

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"We can be explorers in spirit, with a mandate to make this world better by discovering improved ways of living and of doing things… God left the world unfinished for man to work his skill upon. He left the electricity in the cloud, the oil in the earth. He left the rivers unbridged and the forests unfelled and the cities unbuilt. God gives to man the challenge of raw materials, not the ease of finished things. He leaves the pictures unpainted and the music unsung and the problems unsolved, that man might know the joys and glories of creation."

– Thomas S. Monson

Course Description

Engineering Fundamentals is an elective course open to 8th—11th graders at American Heritage School – Salt Lake City. In this course, you will explore various fields of engineering, including architecture, web design, and electrical, mechanical, civil, chemical, nuclear, and software engineering, by participating hands-on projects and field trips. You will learn how engineers think about problems that need to be solved, and you will gain experience with some of the different tools and methods they use to solve those problems. You will also learn about the effects and implications of engineering, historically and in the present. The focus of this course will be to provide you with both the technical knowledge and the big-picture awareness that you, as a disciple-engineer, will need to impact history and participate in harnessing the engineering of our society for the building of the kingdom of God.

Course Structure and Requirements

Projects — Complete each project, along with accompanying documentation, by the end of the unit.

We learn best by doing. For this reason, this course is structured as a series of projects which will help you explore different areas of engineering and then use computer applications (Microsoft Word, Excel, PowerPoint, and Publisher) to document and/or present your experiences. When we begin each unit, written instructions for the unit's project will be given to you, along with a clear due date.

Memorization — Memorize one prophetic quote per term.

Each term, a prophetic quote related to our topics of study will be provided for memorization. We will review the quote periodically in class to aid in the memorization process, but it will be your responsibility to memorize the quote, complete the accompanying reflection, and pass it off. You may pass off your memorization during any class work time; I will simply ask you to repeat the quote from memory and turn in your reflection.

Class Notebook — Maintain your class notebook.

Throughout the year, you will be expected to maintain a class notebook containing class assignments, final reports on class projects, and reflections on what you are learning. Your best work is expected,

including good handwriting and neat organization. Your notebooks will be inspected and graded a couple times each term.

Class Discussions — Prepare for and participate in class discussions.

We will hold regular class discussions on significant topics related to historical innovations and engineering methodologies. You will be expected to carefully prepare for each discussion by reading, annotating, and thinking about a specific article or talk that will be provided to you. On the day of the discussion, you can expect to discuss the article in small groups and as an entire class, and you should be prepared to be called on to share your insights and impressions. You will receive a grade for your participation in these discussions; if you carefully prepare, you will receive a good grade.

Grading

Grades will be assigned according to the standard American Heritage breakdown, as follows:

A = 100-93%	A- = 92-90%	B+ = 89-87%
B = 86-84%	B- = 83-80%	C+ = 79-77%
C = 76-74%	C- = 73-70%	D+ = 69-67%
D = 66-64%	D- = 63-60%	
F = 59-0%		
IN = Incomplete		

A total of 1000 points will be awarded per term. Completion of class requirements will contribute to your grade in the following manner:

600: Projects
200: Class Discussions
100: Class Notebook
100: Memorization

Clear instructions will be given for every assignment. If you follow the instructions carefully and do your best work, you will get a good grade.

Course Materials and Equipment

Laptop and Software — Laptops will be available for use during every class period. Your school account will give you access to the following software packages, which we will use in our course: Microsoft Office (Word, Excel, PowerPoint, Publisher) and Paint. These laptops cannot be taken home. However, each student is issued a Microsoft 365 account, which includes online access to Microsoft programs and Cloud storage space. You are encouraged to store your projects in the Cloud, so you can access them and continue working on them at home. You are also welcome to bring a USB flash drive to class for the purpose of transferring files between school and home.

Code.org — During our unit on computer programming, you will complete exercises on code.org, a website that teaches computer programming using interactive, graphical activities. Please note that this content has not been selected for its entertainment value, but instead for its educational strengths: 1) It allows you to experiment and discover computer programming principles for yourself; 2) it allows you to run programs multiple times and get real-time feedback; and 3) it allows you to progress as fast as you are able to learn. We will only use specific modules of the code.org course, and each principle will also be

discussed verbally in class. If for any reason you would like to review the modules before completing them in class, please email me; all of the modules are free online, and I would be happy to provide links for your review.

Class Policies

Respect for People — The highest standard of respect for others is expected in our class: for your classmates, for all faculty and staff, and for any volunteers who may assist us in any way. I promise to treat you with the same level of respect, for I view the opportunity to interact with you in class as a profound privilege.

Respect for Property — You will have the opportunity to use many supplies and special equipment in this class. These resources were purchased for the school using donated funds. With this understanding, it is expected that all property be cared for as if it was your own. It should be treated with respect, carefully returned when not in use, and left in as good a condition as it was when you received it.

Computer Use — You will have frequent access to the school laptops. You will be expected to use them only for the purposes outlined in class.

Phone Use — In accordance with the policies of American Heritage, phone use in class is not permitted, *with one exception:* In order to complete project reports, you will need photos of your projects, and for that limited purpose alone, you will be allowed to power on your phone and use the camera. If you do not have a phone, or choose not to bring it to class, I will provide other means of taking project photos (you can use the camera on the student laptops, we can enlist the help of other students, or I can take photos for you). You should not feel any pressure or obligation to bring a phone to class.

Due Dates — All work is due on the set due date. If, for any reason, you feel that you need more time, talk with me before the due date. I will be happy to make special arrangements with you, but only if you talk with me beforehand. Otherwise, all late work will incur a 20% late penalty.

Cleanliness — We all need to work together to keep our classroom clean. It is expected that everyone will help to clean up at the end of each class. Once you have finished cleaning up your own work area, please look for opportunities to help others clean up as well.

Group Work — Many of our projects will be completed in groups. It is expected that you will contribute your unique creativity and effort to your group's projects. Fulfillment of this expectation will not be graded — indeed, in most cases, it *cannot* be graded. Nevertheless, on the principles of integrity and trust, you should do your part to help your group succeed.

Questions

How much homework will I have?

The only regular homework you will have will be preparing for our class discussions. At other times, you may need to finish class projects at home, but rarely will you receive other dedicated homework assignments.

Will I be encouraged to use search engines to find information online?

Yes. The use of technology is generally discouraged during class time at the Salt Lake Campus of American Heritage School, as it often distracts from the opportunity to interact with other people — both your teachers and fellow students. However, technology and the Internet are such huge parts of our society and carry such great potential for good that *in this particular class*, you will not only be encouraged to use these tools, but also taught appropriate ways to use them. At no time, however, will "surfing the Internet" or conducting aimless searches be tolerated. Before any Internet research is performed, we will carefully discuss appropriate Internet use, how to identify reputable sources of information, and which search engines and websites are most likely to provide wholesome, accurate, legal information and images. During class periods in which we conduct Internet research, your computer screen will at all times be visible to me and other class members.

If you or your parents are concerned, please contact me. I will be very happy to work with you and to provide alternative activities or resources.

Course Outline

Unit 1: The Role of Engineering in History — Past, Present, and Future

Topics

- The History of Engineering
- Modern Engineering
- The Future of Engineering

Projects

- Creative Machine — Design a Rube Goldberg machine on paper.

Unit 2: Architecture

Topics

- Purposes and History of Architecture
- Primer on Architectural Styles
- Great (and Utterly Boring) PowerPoint Presentations
- The Effects of Architecture on Individuals, Families, Communities, Nations, and the Kingdom of God
- Functionality, Aesthetics, and the User Experience in Architecture

Projects

- Architecture Presentation — Create and present a PowerPoint presentation on two architectural structures.
- Building Models — Create three-dimensional building models from cardstock.

Unit 3: Civil Engineering

Topics

- Civil Engineering in History
- Historical Bridges
- Analyzing and Increasing Bridge Strength
- The Role of Planning, Analytical Design, Calculations, and Simulations in Engineering
- The Role of Experimentation and Iterative Improvement in Engineering

Projects

- Balsa Wood Bridges — Design, build, and test balsa wood bridges, going through multiple iterations to increase the strength of the bridge.

Unit 4: Mechanical Engineering

Topics

- The Application of Physical Principles to Engineering
- The Role of Engineering Requirements and Specifications
- Collaboration, Communication, and Iterative Improvement in Engineering
- Managing Time, Material, and Cost Constraints
- The Role of Aesthetic Appeal in Engineering and Technology

Projects

- Marble Tracks — Build two marble tracks, each designed to meet different requirements.

Unit 5: Electrical Engineering

Topics

- What is Electricity?
- Generating, Storing, Transmitting, and Using Electricity
- Basic Elements of Electrical Circuits
- Circuit Diagrams

Projects

- Snap Circuits — Build various electrical circuits, including an AM radio receiver, using a Snap Circuits kit.

Unit 6: Software Engineering

Topics

- What is Computer Programming?
- Basic Programming and Logical Constructs
- Programming Logic in Everyday Life

Projects

- Code.org — Complete certain modules of a code.org course.

- Create a Webpage — Use basic HTML to create a simple webpage. (Note that this page will be stored locally and will not be accessible to others online.)

Unit 7: Embedded Systems Engineering

Topics

- What is a Microcontroller?
- Electrical Prototyping Using a Breadboard
- Reverse Engineering

Projects

- Arduino and Breadboard Prototyping — Build a series of LED circuits and control the LEDs by programming an Arduino.

Unit 8: Aerospace Engineering

Topics

- History of Flight
- Physical Principles of Flight
- Optimization of Design Variables

Projects

- Bottle Rocket — Build and test a bottle rocket, optimizing it to remain in the air as long as possible.

Unit 9: Chemical Engineering, Nuclear Engineering, and Other Fields

Topics

- Basics of Chemical Engineering
- Basics and History of Nuclear Engineering
- Survey of the Breadth and Diversity of Engineering Disciplines

Unit 10: Final Project

Topics

- What is Engineering?
- Conceptualizing, Planning, and Executing an Engineering Project
- Some Basics of Technical Writing

Projects

- Final Project — Plan, design, and create a portion of a personal engineering project.

Unit 11: Engineering and Innovation

Topics

- The Engineering Design Cycle: What Have We Learned?
- The "Greatest" Innovations of History
- Using Engineering to Build the Kingdom of God

Projects

- Innovation Presentation — Give a presentation to the class on one innovation you believe may be one of the most important in world history.

Course Culmination

At the end of the year, the following will be done to culminate our efforts in this course.

1. Project Display and Demonstration — We will hold an after-school demonstration, in which you will display a couple of your best class projects. This event will be held right after school for approximately half hour and will be open to the public, including your parents and anyone else you would like to invite.
2. Project Portfolio — Throughout the year, you will create graphical reports on your projects. These reports will be assembled in your class notebook to create a portfolio of your work.