Introduction to Engineering

Syllabus

Recommended Grade Level	Grades 9–10
Course Length	Full academic year; six units of 3–4 weeks each
Credit	1.0 high school elective/STEM credit
Pre or Co-requisites	Algebra I

COURSE DESCRIPTION

Introduction to Engineering is a survey course for high school students that introduces the major fields of engineering, the scientific and mathematical principles that underlie engineered systems, and the process engineers use to solve practical problems. Students examine mechanical, civil, electrical, computer, chemical, materials, environmental, aerospace, biomedical, and related engineering fields through readings, case studies, demonstrations, laboratory activities, and design challenges.

The course emphasizes the engineering design process: defining a problem, researching existing solutions, establishing criteria and constraints, generating and evaluating ideas, developing models or prototypes, testing performance, analyzing results, improving the design, and communicating a solution. A culminating engineering project requires students to apply these skills to an original or instructor-approved problem.

LEARNING OBJECTIVES

- Explain what engineering is and how engineering differs from, and depends upon, science and mathematics.
- Identify major engineering disciplines and describe common applications of each.
- Recognize how multiple engineering disciplines contribute to complex products and systems.
- Apply basic principles of forces, motion, energy, structures, electricity, materials, fluids, and systems to introductory engineering problems.
- Use measurements, units, estimation, graphs, and basic calculations in engineering work.
- Apply the engineering design process to open-ended problems.
- Identify design criteria, constraints, tradeoffs, safety concerns, cost, and user needs.
- Create sketches, diagrams, models, and simple prototypes to communicate ideas.
- Collect and interpret test data to evaluate a design.
- Use evidence to revise and improve a prototype.
- Maintain an engineering notebook documenting design decisions and testing.
- Explain the importance of ethics, sustainability, safety, teamwork, and communication in engineering.
- Complete and present an engineering design project.
- Relate course experiences to possible college majors and engineering careers.

Learning Materials

Materials are selected for introductory high school students. The instructor may use equivalent editions or comparable resources.

Resource	Use in Course
Primary Survey Text	Oakes, Leone & Gunn, Engineering Your Future: A Project-Based Introduction to Engineering, Great Lakes Press. Selected introductory chapters/sections on engineering careers, disciplines, design, teamwork, graphical communication, and project work. This publisher specifically offers the text as a project-based high-school introduction to engineering.
Open-Access Design Text	Kenneth Alfano, Introduction to Engineering Design: A Conceptual Overview (Maize Books/Michigan Publishing, 2026). Chapters 1–3: About Engineering and Design; Your Design Problem and Requirements; Design Concept Generation and Development.
Design Curriculum	TeachEngineering, Creative Engineering Design unit (Grade 9, adaptable for Grades 9–12): problem definition, research, brainstorming, alternative evaluation, prototyping, testing, and redesign.
Supplemental Curriculum	TeachEngineering high-school lessons and activities selected for structures, forces, simple machines, fluids, electricity, materials, environmental engineering, and biomedical applications.
Engineering Notebook	Bound composition or laboratory notebook used throughout the year for sketches, calculations, observations, design decisions, test results, and reflections.
Digital Tools	Spreadsheet software for calculations and graphs; student level CAD-type or 3D-design software when available; simulations and engineering calculators as appropriate.

ACADEMIC INTEGRITY

Academic integrity is at the core of education. All academic assignments are essential to the learning experience and to assessing that learning. When students violate the academic integrity policy (i.e., “cheat”), they commit theft that can cause actual harm to themselves and others, including their classmates, instructors, those from whom they steal, and their family and friends. Academic dishonesty confers an unfair advantage over others, which undermines educational equity and fairness and jeopardizes their educational success and future opportunities.
Definitions and Examples of Academic Dishonesty include the following.

a. Cheating is the unauthorized use or attempted use of material, information, notes, study aids, devices, artificial intelligence (AI) systems, or communication during an academic exercise. Examples of cheating include:
    - Copying from another person or from a generative AI system or allowing others to copy work submitted for credit or a grade. This includes uploading work or submitting class assignments or exams to third party platforms and websites beyond those assigned for the class, such as commercial homework aggregators, without the proper authorization of a professor. Any use of generative AI tools must be in line with the usage policy for specific assignments as defined in the course of the syllabus and/or communicated by the course instructor.
    - Using artificial intelligence tools to generate content for assignments or exams, including but not limited to language models or code generators, without written authorization from the instructor.
    - Unauthorized collaboration on assignments or examinations.
    - Taking an examination or completing an assignment for another person or asking or allowing someone else to take an examination or complete an assignment for you, including exams taken on a home computer.
    - Submitting content generated by another person or an AI tool or any other source as solely your own work as your own, including, but not limited to, material obtained in whole or in part from commercial study or homework help websites, or content generated or altered by AI or digital paraphrasing tools without proper citation.
    - Fabricating and/or falsifying data (in whole or in part).
    - Giving assistance to acts of academic misconduct/dishonesty.
    - Altering a response on a previously graded exam or assignment and then attempting to return it for more credit or a higher grade without permission from the instructor.
    - Submitting substantial portions of a paper or assignment to more than one course for credit without permission from each instructor.
    - Unauthorized use during an examination of notes, prepared answers, or any electronic devices such as cell phones, computers, smart watches, or other technologies to copy, retrieve, generate or send information.
b. Plagiarism is the act of presenting ideas, research or writing that is not your own as your own. Examples of plagiarism include:
    - Copying another person's or an AI tool's actual words, images, video, or audio without the use of quotation marks and/or proper citations attributing the words to their source.
    - Presenting another person's ideas or theories in your own words without acknowledging the source.
    - Failing to acknowledge collaborators on homework and laboratory assignments.
    - Internet plagiarism, including submitting downloaded term papers or parts of term papers, paraphrasing or copying information from the internet without citing the source, or "cutting & pasting" from various sources without proper attribution.
    - Unauthorized use of AI-generated content; or use of AI-generated content, whether in whole or in part, even when paraphrased, without citing the AI as the source.
c. Obtaining Unfair Advantage is any action taken by a student that gives that student an unfair advantage in his/her academic work over another student, or an action taken by a student through which a student attempts to gain an unfair advantage in his or her academic work over another student. Examples of obtaining unfair advantage include:

- Stealing, reproducing, circulating or otherwise gaining advance access to examination materials.
- Depriving other students of access to library materials by stealing, destroying, defacing, or concealing them.
- Retaining, using, or circulating examination materials clearly indicates that they should be returned at the end of the exam.
- Intentionally obstructing or interfering with another student's work.

Citations used should be a standard and generally recognized style, such as APA.

Questions concerning Academic Integrity and Citations should directed to instructors or the Head of School.

LATE SUBMISSIONS

Submissions submitted after the announced due date may receive a 10% per day reduction up to 50% of the final grade. Failure to submit course requirements will result in a grade of zero (0) if it is not submitted two weeks after the announced due date.

WORK SCHEDULE

Unit 1 — Engineering: Fields, Careers, and Problem Solving

Students explore engineering as a profession and method of problem solving. The unit surveys major engineering disciplines, practical applications, interdisciplinary work, and the relationship among engineering, science, mathematics, and technology.

Key Topics

- What engineers do
- Engineering vs. science
- Mechanical engineering
- Civil and structural engineering
- Electrical engineering
- Computer engineering
- Chemical engineering
- Materials engineering
- Environmental engineering
- Aerospace engineering
- Biomedical engineering
- Industrial and systems engineering
- Interdisciplinary engineering
- Engineering careers and college pathways

Learning Materials

- Engineering Your Future — introductory sections on engineering, careers, and engineering disciplines.
- Alfano, Chapter 1: About Engineering and Design.
- TeachEngineering — introductory engineering/career activities.

Assessments / Projects

- Engineering fields comparison chart

- Case study: identify the engineering disciplines involved in a familiar product or system
- Short quiz
- Unit survey project: Engineering Field Profile

Unit 2 — Engineering Science: Forces, Motion, Energy, and Structures

Students study physical principles that engineers use when designing machines, structures, vehicles, and devices. Activities emphasize conceptual understanding and practical application rather than advanced mathematics.

Key Topics

- Force and motion
- Newton's laws in engineering
- Work, energy, and power
- Simple machines
- Mechanical advantage
- Torque and rotational motion
- Loads and reactions
- Tension and compression
- Shear and bending
- Trusses and bridges
- Structural stability
- Factor of safety

Learning Materials

- Introductory physics text or instructor readings on forces, energy, and simple machines.
- TeachEngineering — high-school activities on forces, trusses, bridges, and simple machines.
- Engineering Your Future — selected problem-solving and measurement sections.

Assessments / Projects

- Forces and structures quiz
- Simple-machine or mechanical-advantage lab
- Bridge/truss analysis activity
- Design challenge: build and test a load-bearing structure
- Unit assessment

Unit 3 — Electrical, Computer, and Systems Engineering

Students examine how electrical energy, circuits, electronic controls, computers, sensors, and feedback systems are used in engineered products. The unit provides a conceptual introduction suitable for students without previous electronics experience.

Key Topics

- Charge, voltage, current, and resistance
- Ohm's law
- Electrical power
- Series and parallel circuits
- Basic electronic components
- Digital vs. analog signals
- Sensors and actuators
- Microcontrollers and embedded systems
- Computer engineering
- Inputs, processing, and outputs
- Algorithms and logical steps
- Feedback and control systems

Learning Materials

- Introductory high-school physics/electricity readings.
- TeachEngineering — selected electricity, sensor, and control-system activities.
- Arduino Education/Getting Started materials as an optional introduction to microcontrollers and physical computing.

Assessments / Projects

- Circuit concepts quiz
- Basic circuit laboratory
- Systems block-diagram assignment
- Sensor/control demonstration or mini-project
- Unit assessment

Unit 4 — Materials, Chemical, Environmental, and Biomedical Engineering

Students investigate how engineers select and modify materials, transform matter, protect natural resources, and develop technologies for human health. The unit emphasizes the interdisciplinary nature of engineering.

Key Topics

- Properties of engineering materials
- Metals, polymers, ceramics, and composites
- Strength, flexibility, density, and durability
- Material selection and tradeoffs
- Chemical processes
- Mass and energy considerations
- Water and environmental systems
- Pollution prevention and sustainability
- Biomedical engineering
- Biomechanics and prosthetics
- Medical devices and imaging
- Biomaterials and tissue-related applications
- Engineering for human needs
- Life-cycle and environmental impacts

Learning Materials

- Engineering Your Future — selected discipline/application sections.
- TeachEngineering — selected materials, environmental, and biomedical engineering activities.
- Instructor-selected age-appropriate case studies of prosthetics, medical devices, water treatment, polymers, and sustainable design.

Assessments / Projects

- Materials comparison investigation
- Engineering case-study analysis
- Biomedical or environmental design mini-challenge
- Short quiz
- Unit assessment

Unit 5 — Engineering Design, Modeling, Testing, and Communication

Students study the engineering design process in depth and prepare for the final project. They learn that engineering design is iterative and requires balancing performance, safety, cost, resources, environmental impact, and user needs.

Key Topics

- Problem identification
- Stakeholders and user needs
- Background research
- Criteria and constraints
- Brainstorming
- Alternative solutions
- Decision matrices
- Sketching and technical communication
- Models and prototypes
- Testing plans
- Measurement and data collection
- Failure analysis
- Redesign and optimization
- Cost and resource considerations
- Safety and ethics
- Teamwork and project management

Learning Materials

- Alfano, Chapters 2–3: Design Problem and Requirements; Design Concept Generation and Development.
- TeachEngineering, Creative Engineering Design unit.
- Engineering Your Future — selected sections on design, teamwork, graphical communication, and projects.

Assessments / Projects

- Engineering design-process quiz
- Reverse-engineering activity
- Design criteria/constraints worksheet
- Prototype mini-challenge
- Final engineering project proposal and design review

Unit 6 — Engineering Project: Design, Build, Test, and Present

Students complete a culminating engineering project that demonstrates the full design process. The emphasis is on thoughtful problem definition, evidence-based design decisions, testing, improvement, documentation, and communication rather than on producing a commercially finished product.

Key Topics

- Project planning
- Research and specifications
- Design alternatives
- Selection of a solution
- Technical sketches or CAD
- Prototype construction
- Safe testing
- Data collection
- Graphs and analysis
- Evaluation against criteria
- Redesign and improvement
- Engineering notebook
- Technical report
- Oral presentation and demonstration

Learning Materials

- Student-selected background sources appropriate to the project.
- Relevant sections of Alfano and Engineering Your Future used as references.
- TeachEngineering design-process resources and instructor project guidelines.

Assessments / Projects

- Engineering notebook review
- Prototype/design artifact
- Testing and data analysis
- Final engineering report
- Project presentation and demonstration
- Self-evaluation/reflection

CULMINATING ENGINEERING PROJECT REQUIREMENT

Each student or team completes an engineering project that applies concepts from the course. Projects may involve mechanical devices, structures, electronics, environmental systems, biomedical or assistive technologies, materials, computer-controlled systems, or another approved engineering problem.

- Identify a clear engineering problem or need.
- Research the problem and existing approaches.
- Define measurable criteria and realistic constraints.
- Generate and compare multiple design concepts.
- Prepare sketches, diagrams, or CAD drawings as appropriate.
- Construct a model, prototype, or detailed engineering solution.
- Develop a safe and repeatable test procedure.
- Collect and organize performance data.
- Evaluate the design against its original criteria.
- Revise or recommend improvements based on evidence.
- Maintain an engineering notebook.
- Prepare a concise final report and oral presentation.

COURSE ASSESSMENTS

Assessment Category	Weight
Unit assignments and activities	20%
Laboratories and design challenges	20%
Quizzes and unit assessments	20%
Engineering notebook	10%
Culminating engineering project	20%
Final report and presentation	10%

GRADING SCALE

Numerical Grade Range	*Letter Grade*
100.00 – 97.00	A+
96.99 – 94.00	A
93.99 – 90.00	A-
89.99 – 87.00	B+
86.99 – 84.00	B
83.99 – 80.00	B-
79.99 – 77.00	C+
76.99 – 74.00	C
73.99 – 70.00	C-
69.99 – 67.00	D+
66.99 – 64.00	D
63.99 – 60.00	D-
59.99 - 0.00	F

COLLEGE AND CAREER PREPARATION

This course provides freshmen and sophomores with a broad foundation before they select more specialized STEM courses. Students encounter the types of open-ended problems, quantitative reasoning, design tradeoffs, laboratory work, teamwork, documentation, and technical communication that characterize engineering study. The survey format also helps students compare engineering disciplines and identify areas they may wish to pursue in advanced high school courses, college, or technical careers.