Introduction to Engineering Design

Engineering Pathway
Instructor: Mrs. Mary Albrecht
2018-2019
Room: 102

PLTW: IED Course Description

Introduction to Engineering Design (IED) is a high school level foundation course in the PLTW Engineering Program. In IED students are introduced to the engineering profession and a common approach to the solution of engineering problems, an engineering design process. Utilizing the activity-project-problem-based (APB) teaching and learning pedagogy, students will progress from completing structured activities to solving open ended projects and problems that require them to develop planning, documentation, communication, and other professional skills.

Through both individual and collaborative team activities, projects, and problems, students will solve problems as they practice common engineering design and development protocols such as project management and peer review. Students will develop skill in technical representation and documentation of design solutions according to accepted technical standards, and they will use current 3D design and modeling software to represent and communicate solutions. In addition the development of computational methods that are commonly used in engineering problem solving, including statistical analysis and mathematical modeling, are emphasized. Ethical issues related to professional practice and product development are also presented.

Materials Needed

- Students should bring their iPad, pencils, eraser, colored pencils, and their engineering notebook.
- **One flash drive per student will be needed for Inventor, CAD software saved work**
- Lab Equipment and Supplies
    - The lab equipment and supplies should only be used with permission, and should be used with respect
- Extra Classroom Needs if possible:
    - Permanent Markers / Sharpies - multiple colors
    - Kleenex
    - The STEM Department is always accepting donations of recyclable material for design projects.

Assessment Methods

- Grades will be recorded in RenWeb with the following weight per category:
- Daily Work - 10% - (Any worksheets, short assignments, engineering notebook)
- Quizzes - 15%

- Tests - 30%
- Projects 45%

PLTW: IED Unit Summary

- Unit 1 Design Process
- Unit 2 Technical Sketching and Drawing
- Unit 3 Measurement and Statistics
- Unit 4 Modeling Skills
- Unit 5 Geometry of Design
- Unit 6 Reverse Engineering
- Unit 7 Documentation
- Unit 8 Advanced Computer Modeling
- Unit 9 Design Team
- Unit 10 Design Challenges

Unit 1: Design Process

The goal of Unit 1 is to introduce students to the broad field of engineering and a design process that engineers use to develop innovative solutions to real problems. Students become familiar with the traditional big four disciplines of engineering and the extensive array of career opportunities and engineering problems addressed within each discipline. A design process is presented as a structured method for approaching and developing solutions to a problem. The art and skill of brainstorming is emphasized as students begin to develop skill in graphically representing ideas through concept sketching.

Unit 2: Technical Sketching and Drawing

The goal of Unit 2 is for students to develop an understanding of the purpose and practice of visual representations and communication within engineering in the form of technical sketching and drawing. Students build skill and gain experience in representing three-dimensional objects in two dimensions. Students will create various technical representations used in visualization, exploring, communicating, and documenting design ideas throughout the design process, and they will understand the appropriate use of specific drawing views (including isometric, oblique, perspective, and orthographic projections). They progress from creating freehand technical sketches using a pencil and paper to developing engineering drawings according to accepted standards and practices that allow for universal interpretation of their design.

Unit 3: Measurement and Statistics

The goal of Unit 3 is for students to become familiar with appropriate practices and the applications of measurement (using both U. S. Customary and SI units) and statistics within the

discipline of engineering. Students will learn appropriate methods of making and recording measurements, including the use of dial calipers, as they come to understand the ideas of precision and accuracy of measurement and their implications on engineering design. The concepts of descriptive and inferential statistics are introduced as methods to mathematically represent information and data and are applied in the design process to improve product design, assess design solutions, and justify design decisions. Students are also provided with practice in unit conversion and the use of measurement units as an aid in solving practical problems involving quantities. A spreadsheet program is used to store, manipulate, represent, and analyze data, thereby enhancing and extending student application of these statistical concepts.

Unit 4: Modeling Skills

This unit introduces students to a variety of modeling methods used to represent systems, components, and processes in design. Students are provided experience in interpreting and developing multiple forms of models common to engineering. They create graphical models to precisely define design parameters. Student learn to develop mathematical representations (in the form of linear functions) to represent relationships, identify patterns and inform design decisions. Computer modeling is introduced, and students use modeling software to create CAD models to represent simple objects in a virtual 3D environment. The modeling software also provides an efficient method for students to create technical documentation of objects. Students are also provided opportunities to create physical models of design elements and use the models for testing purposes.

Unit 5: Geometry of Design

In this unit students are provided opportunities to investigate two- and three-dimensional geometric concepts and apply statistics to engineering decision making and problem solving. Fluency in these geometric concepts is essential in every phase of the design process as problems are defined, potential solutions are generated to meet physical constraints, alternate design solutions are compared and selected, final designs are documented, and specifications are developed. Geometric concepts are also important in the appropriate application of geometric and dimensional relationships and constraints for effective use of three-dimensional computer modeling environments that employ parametric design functionality. In this unit students develop an understanding of static equilibrium and use geometric concepts and physical properties to solve a wide variety of problems including estimating costs, investigating physical properties to identify materials, and iterating designs to meet design specifications. Students will also use 3D computer models to compute physical properties that can be used in problem solving and creation of design solutions.

Unit 6: Reverse Engineering

Unit 6 exposes students to the application of engineering principles and practices to reverse engineer a consumer product. Reverse engineering involves disassembling and analyzing a product or system in order to understand and document the visual, functional, and/or structural aspects of its

design. In this unit students will have the opportunity to assess all three aspects of a product's design. Students will learn the visual design elements and principles and their application in design. They will perform a functional analysis to hypothesize the overall function and sequential operations of the product's component parts and assess the inputs and outputs of the process(es) involved in the operation of the product. Students will physically disassemble the product to document the constituent parts, their properties, and their interaction and operation. After carefully documenting these aspects of the visual, functional, and structural aspects of the product, students will assess the strengths and weaknesses of the product and the manufacturing process by which it was produced.

Unit 7: Documentation

In unit 7 students will enhance their basic knowledge of technical drawing representations learned earlier in the course to include the creation of alternate (section and auxiliary) views and appropriate dimensioning and annotation of technical drawings. Students will also be introduced to the reality of variation in dimensional properties of manufactured products. They will learn the appropriate use of dimensional tolerances and alternate dimensioning methods to specify acceptable ranges of the physical properties in order to meet design criteria. Students will apply this knowledge to create engineering working drawings that document measurements collected during a reverse engineering process. These skills will also allow students to effectively document a proposed new design. Students will use 3D computer modeling software to model the assembly of the consumer product, as such a model can be used to replicate functional operation and provide virtual testing of product design.

Unit 8: Advanced Computer Modeling

In this unit students will learn advanced 3D computer modeling skills. These advanced skills include creating animated assembly views of multi-part products and using mathematical functions to represent relationships to enforce dimensional and motion constraints. Students will use the skills and knowledge previously built in the course to develop and document the solution to a design challenge using an iterative design process.

Unit 9: Design Team

In this unit students will work as a collaborative team with geographically separate team members, thereby requiring virtual communications. Through the design process, the team will experience shared decision-making as they work to solve a new design challenge. They will reflect on the ethical responsibilities of engineers as they investigate different materials, manufacturing processes, and the short and long term impacts that their decision making may potentially have on society or on the world.

Unit 10: Design Challenges

In this unit students will work in small collaborative teams, implement the design process, and use skill and knowledge gained during the course to solve a culminating design challenge and document and communicate their proposed solution.

PLTW Gateway Notebook

- A chronological documentation of all tasks completed during a design process, including correspondence, ideas, sketches, journal entries related to design, calculations, photographs, class notes, meeting notes, test procedures and data, and other related information.
- In PLTW courses, you may use a single PLTW Gateway Notebook to document design work for multiple projects. However, it is recommended that each project have a separate designated section within the notebook that includes pertinent information for that project only.
- It is important to know that there are many formats used to document work within an engineering notebook.
- The notebook format introduced in PLTW accumulates best practices and presents a standard for the purpose of consistency in the curriculum.
- As you gain experience or are employed in a professional capacity, you will improve and enhance their practice and procedures for the engineering notebook to match preference and company policies which vary widely.
- An engineering notebook, as kept by a professional engineer, is a bound text with quadrille ruled pages. Loose leaf writing paper is generally not acceptable.
- You will be required to keep the bound engineering notebook in your PLTW classes. It is valuable to view a notebook with completed entries as an example.

The course binder (Notability)

- Stores all course materials not included in the engineering notebook such as activities, research, reference materials, and handouts.
- You should keep all of your coursework.

Classroom Expectations

- Students are expected to participate in all curriculum activities, including collaborative group projects for problem-based learning.
- Students are to be prepared for class, which includes class supplies. The BNI discipline policy will be used in the classroom. (Please see the BNI Student Handbook)
- Bring all needed materials to class (Engineering Notebook, pen/pencil, homework, etc.)
- Treat others the way you expect to be treated.
- Follow all directions and safety procedures during laboratory activities.
    - Strict safety procedures will be taught and enforced.
    - Students choosing not to follow these procedures will be dealt with appropriate to the severity of the infraction.

Online Learning Management System

- Students will use an online learning management system (LMS) to do daily tasks such as viewing assignments, turning in work, engaging in discussion, taking quizzes, and receiving feedback.
- Students will need access to this outside of class. Access is given online through my.PLTW.org and Google Classroom(classroom.google.com)

Food and Drink

- The STEM Room will be a food and drink, with the exception of water, free space.
- The STEM Room has a lot of technology, equipment, and supplies.
- The technology, equipment, and supplies work best if food or drink residue is not spilled or in contact with them.

Your signature below indicates that you and your child have read the entire Freshman STEM Syllabus. I look forward to the work that your child will be engaged in this year. If you have any questions, please do not hesitate to ask.

_____ _____

Parent/Guardian Signature Printed Name of Parent/Guardian

_____ _____

Student Signature Printed Name of Student

Date: _____