LATHROP ENGINEERING

Name:

UNIT 4: FRAME DESIGN

Aerospace Engineering Unit Due Date: **November 8, 2019**

Welcome to the fourth unit of *Aerospace Engineering*! This unit is all about how to use Autodesk to design aerospace components. Real aerospace engineers need to model their designs in a computer to test how well they will work before actually building them. The processes and materials used in aerospace design are complex and very expensive; because of this, engineers want to model their work as precisely as possible before actually building it. In our unit, you'll get to learn a few of those modeling tools in Autodesk. In the end, the expectation is that you learn the following:

- The Materials Life Cycle and how it applies to the engineering world
- How different aerospace materials are selected and what properties are considered when choosing them
- How to use Autodesk Inventor's built in Frame Generator tool
- How to use Autodesk Inventor's built in Stress Analysis tool

As we move through this unit, you are responsible for making adequate progress through the assignments, and for being done by the Unit Due Date (**November 8, 2019**). You are also responsible for completing each part before moving on to the next. Our unit is broken up into three main parts:

Part 1: **Frame Materials** *(20 pts) Approx. 2 days*		
The first part of this unit is all about materials. You'll spend a bit of time reading about the different kinds of materials that go into the creation of aircraft. You'll need to make careful note about the various pros and cons of using different materials, and also about the Materials Life Cycle.		Notes on Metalworking & MLC
		Notes on Materials & Properties
		Check-off from Mr. Benshoof

Part 2: **Autodesk Frame Generator** *(80 pts) Approx. 4 days*		
In this part of the unit, you'll get our first chance at using Autodesk for Aerospace work. When designing airplane parts, aerospace engineers need to start with complex computer models. Autodesk has two built-in functions that we'll use to explore engine mounts: the Frame Generator and the Stress Analysis tools. In the second part of our unit, your job is to work through a pair of Autodesk tutorials to learn how these tools work!		Notes on Frame Generator
		Frame Generator Tutorial Activity
		Notes on Stress Analyzer
		Stress Analyzer Tutorial Activity
		Take the Unit 4 Quiz!
		Check-off from Mr. Benshoof

Part 3: **Autodesk Modeling** *(30 pts) Approx. 3 days*		
In the final part of our unit, you'll return to the frame generator and stress analysis tools to investigate a potential frame for mounting an engine in the front of a small plane. The seemingly simple wire model needs to be tested to see if it is strong enough for use in a plane. You'll use the same processes from before for building the frame and analyzing stresses on it.		Build Engine Mount Frame
		Analyze Engine Mount Stress
		Autodesk Reflection
Achievement: Create your own wire model, generate the frame, and conduct a stress analysis		

(20 pts) Approx. 2 days

Aerospace engineers care a lot about materials research because better materials mean more efficient planes! Real planes are made out of a variety of materials: wood, plastic, composites, and metal. Throughout our course, we'll look at different types of materials – the entire Unit 5 for example is all about composite materials – and here we'll take some time to look at metals and metalworking processes. The first part of this unit will review the Materials Life Cycle (MLC). The MLC tries to describe the cycle that things like metal go through when we use it in the manufacture of a product. For example, the steel that ends up in a Boeing 747 needs to harvested as iron from the ground and refined into steel. This process has some byproducts. The steel is then used in the manufacture of planes, and when the plane is old and done being used that steel might be recycled or reused.

As we continue this part, we'll watch three videos on metalworking that help describe different ways that metal can be shared and formed for use in engineering. We'll take some notes on those processes; then we'll look at the details of various materials by watching the *Aerospace Materials* and *Materials Properties* presentations. Take your time and take some good notes.

1. Start by watching the *Materials Life Cycle Assessment* video and reviewing the "Materials Life Cycle" diagram. Begin your notes with ideas about the Materials Life Cycle and how it impacts engineers.
2. Continue your notes as you watch the three (3) Metalworking videos. Most planes are made out of metals, and you want to take a few notes on the different processes used to work with metal. Think also about the Materials Life Cycle and how it fits into the world of metalworking. *You should have 1 full page of notes from these first 4 videos.*
3. Start your second page of notes by reviewing the *Aerospace Materials* and *Materials Properties* presentations. Take good notes, but don't stress too much about any mathematical formulas. The focus here should be on concepts, vocabulary, and general properties rather than specific calculations.

Part 1: Tasks	*10 points*	*8-5 point*	*4-0 points*
Notes on Metalworking & MLC	+ You took a full page of notes on the *Materials Life Cycle Assessment*, and the three *Metalworking* presentations + Your notes include a detailed flow chart of the Materials Life Cycle	- Your notes do not cover all topics - Your notes are lacking important parts	- Your notes are missing - Your notes are missing many important parts
Notes on Materials & Properties	+ You took a full page of notes on *Aerospace Materials* and *Materials Properties* presentations + Your notes include reasonable details	- You did not take a full page of notes - Your notes do not include one of the topics	- Your notes are too brief - Your notes are missing

(80 pts) Approx. 4 days

The second part of this unit is all about using Autodesk Inventor to simulate mechanical structures and a potential engine mount. When engineers build things, they need to simulate their work before spending the time and money to build a physical prototype. Autodesk Inventor is one tool engineers use to build models of their ideas to simulate if they will work or not. The purpose of this part of the unit is to learn two of the tools that Autodesk Inventor has available for doing this simulation work: the Frame Generator and the Stress Analysis Tool.

1. Watch the presentation *Frame Generator & Stress Analyzer Overview* as well as *Frame Generator Tutorial*. Take a full page of notes on these ideas, paying particularly close attention to the tools used in the Frame Generator. The tutorial video itself is about the use of the frame generator, but not specifically the activity you will work on. So take notes about the tools without worrying too much about the specific example.
2. Use Autodesk Inventor to complete the Frame Generator Tutorial Activity. You will need to start with the downloadable wire frame model available on our website. From there, you'll follow the tutorial built in to Autodesk to generate the full frame.
3. Complete the entire frame generation, including all fillets and joints. Print the screen of your finished frame and add it to your notebook.
4. Next, watch the *Stress Analyzer Tutorial* video. This video is also a good example of how to use the different tools in the stress analyzer, but it will not show exactly how to complete our tutorial activity. Take a page of notes about the tools, but don't worry too much about the exact example shown in the video.
5. Next, use Autodesk Inventor to complete the Stress Analysis Tutorial. Use the downloadable wire model from our website for this tutorial. Add all the needed points of contact, and load them with the specified stresses. When you conduct the stress analysis make some notes in your engineering notebook about what the analysis shows you.

Part 2: Tasks	*10 points*	*8-5 point*	*4-0 points*
Notes on Frame Generator	+ Take a full page of notes on how to use the Autodesk Frame Generator	- Less than a full page of notes on the Autodesk Frame Generator	- Very brief or no notes.
	25-20 points	*19-10 points*	*9-0 points*
Frame Generator Tutorial Activity	+ You followed the Frame Generator Tutorial Activity to create the entire metal frame + Your completed frame includes all proper joints	- The completed frame is not complete - The completed frame does not have all the right joints	- You did not make the frame - You clearly did not follow the tutorial
	10 points	*8-5 point*	*4-0 points*
Notes on Stress Analyzer	+ Take a full page of notes on how to use the Autodesk Stress Analysis Tool	- Less than a full page of notes on the Autodesk Stress Analysis Tool	- Very brief or no notes.
	25-20 points	*19-10 points*	*9-0 points*
Stress Analyzer Tutorial Activity	+ You followed the Stress Analysis Tutorial Activity to conduct the stress analysis + Your results are printed and taped into your engineering notebook	- The stress analysis is not complete - The analysis is not included in your engineering notebook	- You did not complete the analysis - You clearly did not follow the tutorial
	10 points	*8-5 point*	*4-0 points*
Take the Unit 4 Quiz!	+ You took the quiz buy the due date + Your grade is based on number correct	N/A	- You did not take the quiz by the due date.

(30 pts) Approx. 3 days

The last part of this unit will ask you to follow the frame generation and stress analysis processes on a wire model of an engine mount. Autodesk is a great tool for simulations, but it takes practice to get good at it. Here, you'll take a wire model and build it out with the frame generation tools just like in the last part, but without step-by-step instructions to follow. Then, you'll investigate the strength of the engine mount using the stress analyzer. Finally, you'll write reflection about the tools and their potential application.

1. Watch the *Autodesk Modeling Overview* video, and take some time to review your notes about the frame generation and stress analysis process.
2. Download the engine mount wire frame from our website. You will use this relatively simple engine mount wire frame for the entire Part 3 activity.
3. Use the frame generator tools and skills you practiced earlier to build a steel frame using the provided wire frame. Be sure to make fillets and joints like you did in the Part 2 tutorial.
4. Then, conduct the stress analysis described in the activity. Use the points of contact and the stresses included in the activity. Decide for yourself if the engine mount is strong enough.
5. Write a full page reflection in your engineering notebook about the simulation process in Autodesk. Include your thoughts about each of the following:
    a. Would the engine mount have been strong enough? How do you know?
    b. What are the possible applications of the frame generator? How might aerospace engineers use the frame generator?
    c. What are the possible applications of the stress analyzer? How might aerospace engineers use the stress analysis tool?
    d. What was the coolest part about Autodesk Inventor as a tool for simulation?

Part 3: Tasks	*10 points*	*8-5 points*	*4-0 points*
Build Engine Mount Frame	+ You built the engine frame using the provided wire model + You built the engine frame completely using the tools practiced in Part 2	- Your engine frame is not totally built - Your engine frame did not use proper techniques	- Your engine frame is nearly incomplete - Your engine frame is missing
Analyze Engine Mount Stress	+ You complete the stress analysis + You include the stress analysis in your engineering notebook	- Your stress analysis is incomplete - Your stress analysis does not use the proper stresses of points of contact	- Your stress analysis is incomplete - Your stress analysis is missing
Autodesk Reflection	+ You wrote a full page reflection about the frame generator and stress analysis tools + Your reflection includes an assessment of whether or not the engine mount is strong enough	- Your reflection is less than a full page - Your reflection does not reference the strength of the engine mount	- Your reflection is missing