

LATHROP ENGINEERING

Name: _____

UNIT 5: COMPOSITES
















Aerospace Engineering

Unit Due Date: **November 27, 2019**

Welcome to the fifth unit of *Aerospace Engineering*! This unit looks at the kinds of composite materials that engineers need to use when designing parts of planes. We'll get to see some videos that point to different kinds of composites, and then we'll work with our own in designing some test samples for looking at both the strength and heat properties of different composites. In the end, the expectation is that you learn the following:

- What a composite material is, and what kinds of composites are in use
- How composites are put together, and what kinds of properties engineers might need to consider
- How composite layering impacts the strength of a composite sample
- How composite layering impacts the thermal properties of a composite sample
- How to balance the different properties of composite layers to reach a complex goal

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 27, 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: Strength Testing (40 pts) Approx. 3 days	
The first part of this unit will have us building some simple composite samples. These samples will need to fit specific size and layer specifications, but once they're completed we'll be able to break them using our SSA 1000 stress analyzer. The data that we get from our samples will be collected and compared to help us make composite material decisions later on!	 Notes on Composites
	 Plan & Build Composite Samples
	 Break Test Samples
	 Check-off from Mr. Benshoof
Part 2: Heat Testing (50 pts) Approx. 2 days	
The second part of our unit also looks at various composites and their properties, but this time we're curious about the heat/thermal properties of the samples. We'll build some very specific composite samples using materials from the lab, and then test to see how well they can resist and dissipate heat. Again, the results from this experiment will inform our decisions about composites in the next part!	 Notes on Thermal Properties
	 Plan & Build Composite Samples
	 Heat Test Samples
	 Take the Unit 5 Quiz
	 Check-off from Mr. Benshoof
Part 3: Re-Entry Design Challenge (40 pts) Approx. 3 days	
The final part of the unit is about combining your knowledge on the strength of various composites as well as the thermal properties of composites. The goal is to create a single "tile" for space shuttle re-entry that is both strong enough, heat resistant enough, and small enough to work on a new space shuttle!	 Document Design Process
	 Design, Built, Test Your Tile
	 Conduct Final Tile Test
	 Re-Entry Design Challenge Report
	 Check-off from Mr. Benshoof
 Achievement: Create a shuttle tile that fits all required parameters for cost, size, strength, AND heat	






(40 pts) Approx. 3 days

Nowadays, planes and space craft are made of a wide variety of materials. From wood, metal, and plastic, to a wide range of *composites*. Composites are materials that are built up in layers from different kinds of materials. In a simple way, your school binder might be an example of a composite if the folder part of it has a cardboard center, then a cloth or vinyl covering. Composites allow an engineer to layer materials with different properties in order to achieve specific goals of strength, thermal properties, flexing or twisting properties, or size.

In this part of the unit, you and your fellow Aerospace students will create a wide range of composite test samples, and then see how strong they are by breaking them in the SSA 1000 press. As you design and build your samples, make sure that they follow the sizing criteria – samples of the wrong size may not fit in the SSA 1000 press!

1. Start by watching the *Composite Materials*, *Building Composites*, and *Breaking Composites* presentations. Take a full page of notes on these ideas. Make sure that your notes include a flow-chart for the process of building and breaking our composite samples!
2. **Build Your Samples:** Each person is responsible for creating and testing three (3) different composite samples. Every sample must be 12” long and 2” wide. The thickness of each sample will differ based on the sample you choose to make.
 - a. Each sample must have a foam core of either 0”, ¼”, ½”, or ¾” thickness
 - b. Each sample must have layers of Woven Fabric (fiber glass or carbon fiber) on both sides of the foam in groups of either 0, 1, or 2 layers.
 - c. If you want a special composite, you can have 1 that is more complex... like:
1 Fabric layer – 1 foam layer – 1 fabric layer – 1 foam layer – 1 fabric layer
 - d. All layers will be glued together with 2-part epoxy
3. **Break Your Samples:** Each person is responsible for breaking their own samples in the SSA 1000 stress analyzer (press). You will need to drill a hole in each sample so it can get loaded into the machine, then you will press and break each of your composite samples. Make sure that you get a SCREEN SHOT of the break graph for each sample and print it for your notebook. Also, share the breaking point of each sample in the class spreadsheet.





Part 1: Tasks	10 points	8-5 point	4-0 points
 Notes on Composites	+ You took a full page of notes on <i>Composite Materials</i> , <i>Building Composites</i> , and <i>Breaking Composites</i> + Your notes include details about this unit’s building process	- Your notes do not cover all topics - Your notes are lacking important parts	- Your notes are missing - Your notes are missing many important parts
 Plan & Build Composite Samples	+You made a written plan and drawing that describes how you will build your composites + You successfully built your 3 needed samples per person	- Your written plan is too brief - You only built 2 samples	- Your notes are missing - You only built 1 sample - You built no samples
 Break Test Samples	+ You successfully tested all 3 samples + You got a picture of your break graphs + You shared your data to the class spreadsheet	- You tested fewer than 3 samples - You did not get pictures of the graphs - You did not share the data	- You did not test any samples - Your work is missing multiple parts



(50 pts) Approx. 3 days

Composite materials have a variety of properties that we can use to our advantage. Engineers look for composite materials that are strong because then they can make more durable designs that are lighter or less expensive. In addition, composites can also have hybrid thermal (heat) properties that can make them more resistant to heat than simpler materials. In this part of the unit, you'll design different composite tiles that might be able to withstand greater and greater amounts of heat!

1. Start by watching the *More About Composites*, *Thermal Properties*, and *More About Thermal Properties* presentations. Take a full page of notes on these ideas. Make sure that your notes include examples of how different composites are used in for their thermal properties.
2. **Build Your Samples:** Each person is responsible for creating and testing three (3) different composite samples. Every sample must be a square that is 6" long and 6" wide. The thickness of each sample will differ based on the sample you choose to make.
 - a. The samples must be made of the materials available: foam, wire mesh, foil, etc
 - b. The samples must be able to hold themselves together (they must be wired or glued into a single piece
 - c. Each sample needs an eye-bolt hot-glued to the center of one side for mounting in our testing device.
3. **Burn Your Samples:** Each person is responsible for burning their own samples using the blowtorch. Talk with Mr. Benshoof as you set this up and before you burn any samples. The fume hood must be on, and the data collection must be monitored at all times. You will collect data on how long it takes for the temperature on the back to increase to a certain threshold OR how long it takes for the hot-glue to melt and the tile to fall off the mount. Again, talk with Mr. Benshoof to confirm the data collection process!






Part 1: Tasks	10 points	8-5 point	4-0 points
 Notes on Composites	+ You took a full page of notes on <i>More About Composites</i> , <i>Thermal Properties</i> , and <i>More Thermal Properties</i>	- Your notes do not cover all topics - Your notes are lacking important parts	- Your notes are missing - Your notes are missing many important parts
	15 points	14-9 point	8-0 points
 Plan & Build Composite Samples	+You made a written plan and drawing that describes how you will build your composites + You successfully built your 3 needed samples per person	- Your written plan is too brief - You only built 2 samples	- Your notes are missing - You only built 1 sample - You built no samples
 Burn Test Samples	+ You successfully tested all 3 samples + You collected your data as described by Mr. Benshoof + You shared your data to the class spreadsheet	- You tested fewer than 3 samples - You did not get the proper data - You did not share the data	- You did not test any samples - Your work is missing multiple parts
	10 points	8-5 point	4-0 points
 Take the Unit 5 Quiz	+ You took the Unit 5 Quiz by the due date + Your grade will be based on the number you get correct	N/A	- You did not take the Unit 5 Quiz



(40 pts) Approx. 3 days

The final part of the unit has you combine those ideas to try and create the best space shuttle tile you can! The space shuttle (and other vessels that travel to/from space) need to be covered in composite tiles that are BOTH strong AND heat resistant. They need to be strong so that they can deflect small debris as the shuttle travels through the atmosphere. They need to be heat resistant because a great amount of heat is generated as the shuttle re-enters the atmosphere.

1. Watch the *Re-Entry Design Challenge* video, and take some notes on the parameters provided there and in this document.
2. Work with your other Aerospace students to create a design brief, brainstorm list, and plan for what tile structures might meet the following parameters:
 - a. CRITERIA: Be able to be as strong as possible AND with stand as much heat as possible
 - b. CONSTRAINTS: Tiles must be 6"x6" for the thermal test and 12"x2" for the strength test
 Tiles cannot be more than 1" thick
 Tiles must be made of a combination of the same materials used earlier in the unit
3. Do some prototyping and try a few things out!
4. Decide what final tile you'd like to make and create 2 samples of if (one for breaking, one for burning)
5. Do your final test of your shuttle tile!
6. Write a full page reflection in your engineering notebook. This reflection should include ideas about what you learned about composites in the unit. What surprised you? What did you properly anticipate? What was most fun about the unit? What was most frustrating? How could you make an even better shuttle tile?

Part 3: Tasks	10 points	8-5 points	4-0 points
 Notes & Brainstorming	+ You took notes on the project + You created a design brief + You recorded your brainstorming + You worked with a team (when possible)	- You missed an important part of initial steps	- You did not work with a team (when you could have) - You did not take any notes
 Build and Test	+ You worked with your team to try a variety of options before making a final choice	- You did not do much testing/prototyping before choosing a final design	- You did no prototyping or testing
 Choose Your Solution	+ You worked with your team (when possible) to select a final design	- You did not settle on a final design	- You did not work with a team when you could have
 Final Testing	+ You completed your final testing on your shuttle tile + You shared your results via the class spreadsheet	- You only did part of your final testing	- You did not share your results - You did not do the final testing
 Re-Entry Challenge Report	+ You wrote a full page about the composites unit and what you learned	- You wrote most of a page but not a full page	- You did not write your reflection, or it was substantially lacking

