LATHROP ENGINEERING

Name:

UNIT 3: NAVIGATION

Aerospace Engineering Unit Due Date: **October 18, 2019**

Welcome to the third unit of *Aerospace Engineering*! This unit is all about flight and navigation. As Aerospace Engineers we need to be able to consider the challenges that pilots face as they try to fly planes. They need to be able to take off and land safely, keep the airplane trimmed out while in the air, navigate properly, and communicate with air traffic control towers. In this unit, we'll look at many facets of the pilot's job so we can consider how pilots interact with their aerospace craft. In the end, the expectation is that you learn the following:

- The basics of how to fly a Cessna 172 and how to read the "Six Pack" of gauges
- How to navigate in a plane during a short flight
- What Air Traffic Control systems need to consider as they track flights
- How to organize planes in the air like an air traffic controller
- How to read section charts and plan complex VOR flight paths
- How to fly using VOR navigation to tell you where to go!

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 (**October 18, 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: **Cessna 172** *(20 pts) Approx. 2 days*		
The first part of this unit is all about getting used to what it's like to try and fly a plane. We'll be working in a flight simulator called XPlane that will do a very good job of demonstrating what it's like to fly a simple plane. We'll use the Cessna 172 and learn to take-off and land, look at what the different dials tell us, and complete a short flight.		Setup Your Joystick
		Learn to Takeoff & Land
		Take Notes on VOR Navigation
		Complete Cross Country Flight
		Check-off from Mr. Benshoof

Part 2: **Air Traffic Control** *(40 pts) Approx. 3 days*		
This second part gives you the chance to learn about the job of an air traffic controllers. You'll start with a few notes about Air Traffic Control in general, and then we'll look at NASA's "Sector 33" Air Traffic Control simulator. We'll look through the math it takes to successfully guide planes and complete a variety of simulation challenges.		Notes on Air Traffic Control
		Complete Easy ATC Simulations
		Complete Hard ATC Simulations
		Take Navigation Quiz
		Check-off from Mr. Benshoof

Part 3: **VOR Navigation** *(40 pts) Approx. 4 days*		
In this final – and most challenging – part of the unit, your job is to learn how VOR navigation works. In doing so, you'll learn how to read real section charts and use them to plan out flight paths using VOR towers and VOR navigation. You'll then get into your Cessna 172 in XPlane and actually fly the entire route that you put together along with a safe take-off and landing! Finish things up with the post-flight reflection!		Notes on VOR Navigation
		Complete Section Map Activity
		Plan & Fly VOR Route
		Post-Flight Reflection
Achievement: Have your VOR route draw a picture and fly it well enough to see the picture in the flight map		

(20 pts) Approx. 2 days

The first part of our unit on navigation is about learning to fly a Cessna 172. Our class uses a program called "X-Plane Learn to Fly" as a flight simulator to learn about the different controls and navigational tools available to pilots. We'll start with some simple flying and playing around in the simulator to get used to it, and then we'll dial in a specific flight path and learn what it takes to go from point A to point B flying on your own! Before you're finished, you'll have completed two long distance flights in XPlane.

1. Start by watching the presentations on flying in XPlane: *First Flight* and *Getting Started in XPlane*
2. Take a few of notes on XPlane, including details about the program itself and what keys to bind for your joystick controls. Feel free to print the reference document to include for your notes!
3. Now, use those as a guideline to get your joystick controls setup properly.
4. Now, with the Cessna 172 ready to fly, learn to take-off and land. The *First Flight* video has some good insights into taking off and landing successfully. Make sure that you can control your plane as you take-off and land 3 times without crashing!
5. Now, watch the *Cross-Country Flight* and *KCOS-DEN Fly Through* presentations. Take some notes on how the pilot is navigating their plane. How do they know where they are going? Take a full page of notes on VOR Navigation and the ideas presented in these videos.
6. Next, complete the cross-country flight from KCOS to Pueblo Memorial airport. You need to take off successfully, navigate in as straight a route as possible, and then land at the proper airport. Use the navigation tools and your flight map to find the right airports!
    a. Note: When you get up in the air and are flying, it's okay to increase the speed to X2 or x4 so that you're not flying for 45 minutes… maybe don't go to the max speed, because you'll zoom past the airport, but you can increase the speed once you're in the air so you don't have to just sit and stare at the screen for too long.

Part 1: Tasks	*5 points*	*4-3 point*	*2-1-0 points*
Learn to Takeoff & Land	+ You set up the joystick following the suggested controls + You were able to take-off and land successfully 3 times + You flew from KCOS to DEN	- You were only able to take-off and land successfully 1 or 2 times - You did not fly from KCOS to DEN	- You could never take-off and land
Take Notes on VOR Navigation	+ You took a full page of notes on the *First Flight*, *Getting Stated in XPlane*, and the *Cross-Country Flight* presentations + Your notes include specific information about the "6-Pack" of dials	- You did not take a full page of notes - Your notes do not include much information on the "6-Pack" of dials	- Your notes are too brief or incomplete
	10-8 points	*7-4 point*	*3-0 points*
Complete Cross Country Flight	+ You successfully completed the cross-country solo flight from KCOS to Pueblo Memorial	- You got most of the flight done, but never landed - Your path is extremely wiggly	- You did not do the cross-country flight - You landed at the wrong airport

(40 pts) Approx. 3 days

The second part of our unit is even more mathy as we look at how Air Traffic Control professionals are able to manage the incoming flights for multiple aircraft at multiple terminals. The job of an air traffic controller is to make sure that all the incoming and outgoing flights at an airport can take off, land, or pass by an airport without getting in each other's way. In tiny remote airports where maybe just one flight lands per day, that might not be too difficult; at larger airports like Fairbanks, Anchorage, Seattle, or New York that job gets increasingly difficult. Air traffic controllers need to consider a variety of factors – plane speed, flight paths, weather patterns, and schedules – while making decisions to help pilots travel through an area. In this unit, we'll use NASA's *Sector 33* Air Traffic Control simulation to look at how some of these problems develop!

1. Watch the presentation on the *Air Traffic Control Simulator* and *Air Traffic Control Hints*. Start a page of notes on these ideas that you can add to as you work through different air traffic control puzzles.
2. Next, follow the link on our website to go to *NASA's Sector 33 ATC Simulation*. This simulation does a good job of presenting a variety of puzzles that require us to consider different factors as we guide planes into and through their destination.
3. Start by solving the first 2-plane Air Traffic Control puzzle (the default one that opens when you open the simulator). Look at how you can change both the **path** and the **speed** of each plane individually.
4. Next, complete four (4) more 2-plane challenges. You can pick the challenges you want to complete from the list.
5. Next, complete a total of five (5) 3-plane challenges from the list of options.
6. Next, complete a total of five (5) 4-plane challenges from the list of options.
7. Finally, complete a total of five (5) 5-plane challenges from the list of options.
8. Confirm with Mr. Benshoof that all of your ATC Challenges are completed!
9. Take the Unit 3 Quiz on Navigation **by October 11**

Part 2: Tasks	*10 points*	*9-5 points*	*4-0 points*
Notes on Air Traffic Control	+ Take a full page of notes on the *Air Traffic Control Simulator*, *ATC Hints*, and *ATC Calculations*	- Less than a full page of notes on air traffic control	- Very brief or no notes.
	5 points	*4-3 points*	*2-1-0 points*
Complete 2-Plane ATC Simulations	+ You solved 5 of the 2-plane Air Traffic Control Scenarios	- You solved fewer than 5 2-plane challenges	- You solved fewer than 3 of the 2-plane challenges
Complete 3-Plane ATC Simulations	+ You solved 5 of the 3-plane Air Traffic Control Scenarios	- You solved fewer than 5 3-plane challenges	- You solved fewer than 3 of the 3-plane challenges
Complete 4-Plane ATC Simulations	+ You solved 5 of the 4-plane Air Traffic Control Scenarios	- You solved fewer than 5 4-plane challenges	- You solved fewer than 3 of the 4-plane challenges
Complete 5-Plane ATC Simulations	+ You solved 5 of the 5-plane Air Traffic Control Scenarios	- You solved fewer than 5 5-plane challenges	- You solved fewer than 3 of the 5-plane challenges
	Up to 10 points		*0 points*
Take Unit 3 Quiz	+ You took the Unit 3 Quiz on the website by the Quiz Due Date + Grade is based on number correct	N/A	(0 pts) You did not take the Unit 3 Quiz

(40 pts) Approx. 4 days

The last part of this unit returns to the idea of navigation from the perspective of the pilot. When flying a plane, it's essential to know where you are and where you are going. VOR Navigation is a worldwide system that makes this possible for all pilots. In this part of the unit, we'll look at some of the Section Maps used to plan out flights, and how the VOR dial and dashboard 6-pack in the cockpit of the Cessna 172 can be used to aid in flight navigation.

1. Watch the videos *Section Charts*, *Planning with VOR,* and *Flying with VOR.* Take a full page of notes on these ideas in your engineering notebook. Make sure that your notes include details on the 6-pack of indicators on a plane's dashboard, as well as how VOR notation works. You'll be able to add to these notes as you continue working!
2. Next, get the two small sector maps (both printed on the same page) and cut them apart. One is of the Fairbanks area, the other is of an area in Wisconsin with locations listed like "Kettle Moraine" and "Lake Winnebago".
3. ***SECTION MAP ACTIVITY:***
    a. Using the **Wisconsin** Section Map, identify and annotate each of the following:

Find VOR-FALLS	Find VOR-OSHKOSH	Find the MANITOWOC VOR frequency
Find the VOR bearing from FALLS to OSHKOSH	Find an airport. They look like this: 	Draw a plane at the location which has a bearing of 160 on Freq 111.8 and a bearing of 240 on Freq 111.0

    b. Next, using the **Fairbanks** Section Map, identify and annotate each of the following:

The city of Fairbanks	The city of Manley Hot Springs	The Tanana River
Find the VOR bearing from NENANA to FAIRBANKS	Find the FAIRBANKS VOR frequency	Draw a plane in the circle at ***Minto Wright*** and then find the VOR bearings for that plane back to FAIRBANKS and to NENANA

4. Next, go back into XPlane and open the section map available for the region in which we can fly. This Section Map is from the Colorado area. Pick a starting airport and an ending airport. Then, plan out a flight between the airports using VOR and the available stations. *Write down your flight plan* in you engineering notebook. Then, *complete your flight* by following your flight plan as closely as possible. Take a screen shot of your finished route
5. Finally, write a full-page reflection in your engineering notebook about navigation. What parts of the unit were interesting and fun? What parts of navigation where difficult or tedious? What do you think it would be like to be a pilot? What kinds of tools, processes, or technology would help pilots have an easier time flying?

Part 3: Tasks	*10-9 points*	*8-5 points*	*4-0 points*
Notes on VOR Navigation	+ You took a full page of notes on *Section Charts, Planning VOR,* and *Flying VOR* presentations.	- Your notes are less than a page or are missing parts	- No notes - Large parts missing
Complete Section Map Activity	+ You completed the Section Map Activity + You taped your annotated Section map into your engineering notebook	- You completed most of the Section Map Activity	- You did not complete the Section Map Activity
Plan & Fly VOR Route	+ You planned out a flight using a section map & VOR stations. + You used the Cessna 172 to fly your planned route + Your flight map looks like your plan	- Your flight did not turn out as planned - Your plan is not fully recorded in your notebook	- You did not make a flight plan - You did not fly your route
Post-Flight Reflection	+ You wrote a full-page reflection in your notebook that addresses the reflection prompts above	- Your reflection was less than a full page	- You reflection was less than a half-page