Modeling Problem – Choosing a Mode of Travel
Part 1 – Developing your Mathematical Model (Written Solution)

Problem:

Please note this problem was developed as a class problem and anything about how the university plans to address expanding parking, transportation problems, etc. is not the goal of this assignment.

Embry-Riddle Aeronautical University's (ERAU's) Daytona Beach (DB) campus is a growing campus in many ways, including our student population. Over the past few years the number of incoming students to the Daytona Beach campus has increased by a couple hundred every year. **ERAU Daytona Beach Campus's Parking Committee has challenged all of the EGR 115 students, including you, to individually develop a computer program (with an effective underlying model) that will predict students' mode of transportation.** Predicting how students will travel to class based on information they know about each incoming student will help the committee better understand the needs of the growing population. Each of the programs will be evaluated using historical data to determine the most effective models. The top programs will be selected to help inform them in their decision to develop, improve, expand, and change current bike lock mounts, longboard/skateboard storage lock areas, parking lots, sidewalks, etc.

The Parking Committee has provided you with survey results for 15 ERAU DB campus students about their mode of transportation to class from home and back (data is included in this document). Your job is to use provided data about current students' mode of travel to campus to develop a model (e.g., logic tree, decision model, algorithm) to predict if a student will walk, drive, bike, board, carpool, or use a ride service (e.g. Uber and Lyft) depending on a variety of given data (i.e. live on or off campus, own a car, parking permit cost, own a bike, bike registration fee, own a bike lock, bike lock lease fee, and own a board).

Eventually the Parking Committee will want a computer program, which will require you to write code; THAT WILL NOT BE AN ACCEPTABLE SUBMISSION FOR THIS PHASE OF DEVELOPMENT THOUGH. **Prior to writing any code, the Parking Committee wants you to EXPLAIN your model for predicting a student's mode of transportation. You must submit a written response to describe your model to the committee.** (*Note: If your class has a standardized algorithm format, you must use it for this submission. If not, you may use any form for your step by step directions, and you may supplement your directions with a diagram, flowchart, or some other drawing.)* Additionally, be sure to include recommendations for more information that the Parking Committee could be asking when collecting data from students about their mode of transportation to school that could help you build a more accurate model.

In addition to your written solution to this problem, you must include the resulting predictions based on your model for the 15 students included in the survey data and a percentage of how many students your model predicted correctly (compare the mode of transportation that your model predicted to the mode of transportation that the student stated in the survey). (EXAMPLE: If your model output the same mode of transportation for 6 out of the 15 students, then your model/code would be 40% accurate.) *Note: If you get 100% accuracy, I bet you did not develop an efficient model; I bet you have far too many specific scenarios and conditions that go through each student individually and does not identify patterns in the data.*

Submissions:

Please note that the submission for this assignment is different than any of your homework assignments. This modeling problem is worth 10% of your grade. This first submission is worth 4% of your final grade, hence it requires more work than usual. **This submission is a written model to solve this problem**, as described in this document. **It will be due in about two weeks.** You will complete this submission as a team of two that you choose or by yourself (refer to Canvas for exact dates). Later, you will receive two other assignments to continue your solution; these future assignments will be individually completed (2nd submission: pseudo code/algorithm; 3rd submission: coded solution – computational model).

- (Part 1 due first) Your model description – for this submission you must complete the Engineering Process (steps 1 to 6 only), as described in the document. Your submission **MUST BE TYPED, submissions written on paper will NOT be accepted**. You must also follow these additional guidelines: Keep in mind ***assumptions*** will be very important for your user to understand the constraints and limitations for using your solution. For your solution step (Step 5), **you must explain why you solved the problem the way you did** – meaning you must explain your rationale for designing the step the way that you did (*refer to the example provided in the bullet point below*). In addition to your written model description, **you must provide the outputs of your model** based on the provided data.
    - Example of a step and justifying it (keep in mind this example may not be a good solution to this problem – we can't give you all the answers!): If a student lives off campus, they are more likely to drive to school so there will be an 80% chance of this occurring. *Rationale: I think most people I know that live off campus drive to campus.*

Solution:

Below are the 7 steps of the engineering process discussed in the videos. They are also shown in Figure 1. Remember these steps are used to guide you through solving a problem. Also remember that sometimes you will cycle through these steps, as shown by the arrows in Figure 1.

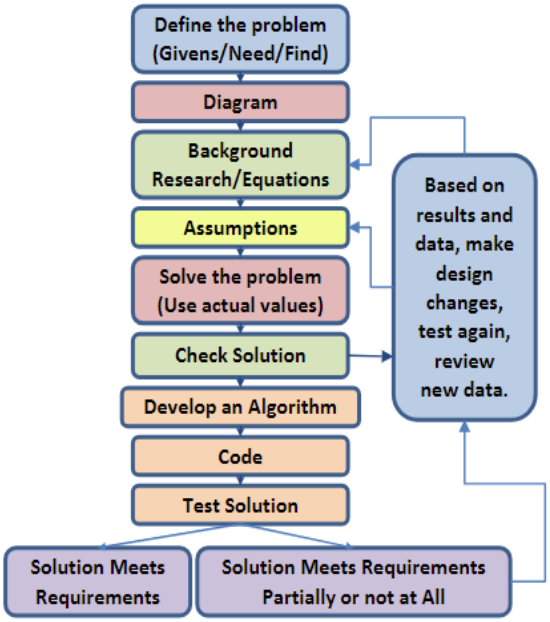

Figure 1. *Engineering Process (from Engineering Process EdPuzzle video)*

1. Decipher Problem Statement

The first step is to decipher the problem and identify the information (or variables) given and what information you need to find (or display to the user at the end of your program).

Givens *(inputs)*:

A data set of students' responses about where they lived and their access to different forms of transportation (i.e. live on or off campus, if on-campus (which residence hall), if off-campus (how many miles away), own a car, parking permit cost, own a bike, bike registration fee, own a bike lock, bike lock lease fee, and own a board). ***This data set can range in sizes*** *based on how many students' modes of transportation the committee is trying to find; the given data set provided for this round is 15 students.* Keep in mind, there are no user inputs nor data collected through your solution. Your solution is only based on the provided data set, which again can have a varying number of students.

Finds *(outputs)*:

The resulting predictions based on your model for the given data set. *(For example: Consider a model that states that all students living on-campus walk and all students living off-campus drive, the model would predict walk for students 1-7 and drive for students 8-15)*

The accuracy of the model. *(For example: Again consider a model that states that all students living on-campus walk and all students living off-campus drive, the model would accurately determine 8 of the 15 students' transportation modes – making it 53% accurate. This accuracy can be used to help evaluate your model.)*

2. Draw a Diagram

Sometimes the problem will include a diagram; be sure to still draw your own diagram/s. This step will help you better decipher the problem by visualizing it. For this problem, you are not required to submit anything for this step. If you do draw something though, please include it.

3. Identify Relevant Theory

After determining the information that you know and need to find and drawing a diagram, you should start to have an idea what theory or background information you need to solve the problem. In this step you will identify the theory (e.g., formulas, data) that you will need to solve the problem.

Some of the relevant background information for this problem is the survey data provided by the Parking Committee (see the provided data set of the 15 students below). You are not required to

look up sources about college students' typical mode of traveling to campus, but this is an example of additional information that can help you develop a better model and something you can do for this step in the problem-solving process.

Survey Results for 15 ERAU Students: This data should be used to help you develop a model that can predict each student's most likely mode of transportation based on their current circumstances (i.e., if they live on/off campus, if they own a car, how much parking passes cost, if they own a bike, if they own a bike lock, how much bike registration and locks cost, if they own a board). You may determine that some pieces of information about their current circumstances do not impact their decision. Be sure to explain if, how, and why (or why not) you used each piece of information provided. Be sure to provide evidence (based on the data provided, additional research, or your own experience) for each step of your model.

Student:	TRAVEL MODE:	On-Campus or Off-Campus:	Own A Car:	Parking Pass:	Own A Bike:	Bike Registration:	Own a Bike Lock:	Lease-A-Lock:	Own A Skateboard, Longboard, other?
1	walk	ON	N	$150/year	Y	Free	N	$35/lock (refundable)	N
2	walk	ON	N		Y		N		N
3	bike	ON	N		Y		N		N
4	bike	ON	N		Y		Y		N
5	bike	ON	N		Y		N		N
6	walk	ON	Y		N		N		N
7	drive	ON	Y		N		N		N
8	uber	OFF	Y		Y		N		N
9	drive	OFF	Y		Y		Y		N
10	drive	OFF	Y		Y		Y		N
11	carpool	OFF	Y		Y		Y		N
12	drive	OFF	Y		Y		Y		N
13	drive	OFF	Y		Y		Y		N
14	drive	OFF	Y		Y		Y		N
15	bike	OFF	Y		Y		Y		N

4. Assumptions

In this step you will communicate some ideas that you have assumed to simplify the problem. These are things that you may try to address later on to make your solution address a more realistic scenario. It is okay if you cannot envision how you would solve the problem without the assumption but try to think about this for each assumption that you write.

For example: Again, consider a model that states that all students living on-campus walk and all students living off-campus drive. For this model I would say that I assumed it does not matter if someone has a car, bike, or board. Based on this assumption, I would evaluate it as a very poor model because it does not consider much of the provided data (and as we calculated, it has a low accuracy).

5. Solution Steps

This step requires solving for the finds using the givens and theory. For this step you may create equations to solve the problem, but you will not plug in any numbers yet. Be sure to base your equations on variables and NOT numeric values (unless they are a constant, such as pi). You may also develop a process with steps or some type of a logic tree. Be sure to also refer to your diagram and assumptions to help you through this step. At some points in this step you may find it useful to go back and draw another diagram or necessary to use another formula or find more data.

For example: (Considering this same poor model, here would be the solution and rationale for the steps. This is what would be submitted for Step 5 for this model.)
Step 1. If the student lives on campus, they will walk. Anyone on campus already will always walk to class because that is what I do.
Step 2. In all other cases (the student lives off campus), they will drive. People I know off campus drive, so everyone else must.

It can also be helpful to use one of the data points as an example of how to apply your model, as you are explaining your solution.

6. Identify Results and Verify Accuracy

Now that you have developed your solution to the problem without plugging in values (or specific data), you will plug in values (e.g., provided data) for this step to verify if your problem is accurate or not.

This is the step where you will generate your outputs that were previously established in Step 1 Finds: (1) the predictions for each student and (2) the accuracy of the model.

7. Algorithm and Code (DO NOT COMPLETE)

Your solution steps will lay out the process that you will need to code. In complex problems that require conditionals and/or repetition, it may be beneficial to draw out a flowchart, concept map, etc. or write out bullet point or numbered steps. Doing this step can ensure you understand the flow of your code before you start writing code in MATLAB.

Since you are tasked with developing a model to solve the problem on paper and **NOT** coding your model yet, you are not required to do anything for this step. The next submission for this assignment will focus primarily on this step.