# Simulation Part I

ES100

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# Points of Discussion

- Simulation project overview and goals
- Project Groups
- Report writing
- Simulation task statement
- Simulation program outline

# Simulation Overview

- Simulate the performance of a wheeled vehicle over a given road course.

- Evaluate the vehicle's performance in terms of time and energy expense required for the vehicle to complete the course

- Execute a parametric study of performance vs. vehicle characteristics, *i.e. vehicle mass, drag area*

- Report results using standard engineering protocol in a modestly comprehensive written report

# Project Work Groups

- For the simulation project, you are asked to work in teams of two(2). Groups are restricted to partners who share the same recitation section.

- Working in groups is an important part of engineering. Thus, project tasks should be distributed fairly between partners while maintaining feedback on decisions of mutual concern.

- Groups are required to "register" with the instructor

# Report Writing -General

- Components of an engineering report
    - Abstract
    - Introduction
    - Procedure
    - Data Reduction
    - Results
    - Conclusions

# Abstract

- The <u>Abstract</u> is a brief overview of the report. Key words, important concepts, and major significant results should be identified, but without going into great detail.
- The Abstract is usually limited to a single paragraph.

# Introduction

- The <u>Introduction</u> is where pertinent theory is explained in detail. As the theory and background information is presented, parameters relevant to the study should be defined. Also, it should become clear to the reader why the study needs to be done.

# Procedure

- The <u>Procedure</u> is not necessarily a step by step explanation of how the problem was attacked but rather an outline of what parameters are controlled (independent) and what dependant variables are sought.

- If a physical experiment is being executed, then the procedure should include discussion of instruments used, physical constraints, and the range of applicability of both testing apparatus and the results.

# Data Reduction

- The <u>Data Reduction</u> section should outline the methods used in transforming the raw data to the results which are sought, as outlined in the Introduction.

# Results

- The <u>Results</u> section is where engineering analysis of the final product takes place.

-  This may include a detailed discussion of plots, comparisons between different experimental cases are made, and reasons why things happened they way they did are offered.

- Also, experimental and numerical error should be discussed in terms of result reliability.

# Conclusion

- The <u>Conclusion</u> should contain an overview of the study concentrating on the results obtained. Comparisons of the present results to prior work are of particular interst. Direction for future work may be suggested here as well.

# Simulation Task Statement

- The data file roaddata.txt, describes a road course to be navigated by a wheeled ground vehicle.

- Use the data file as inputs to a MATLAB program to march through time compute the energy required to navigate the course.

- *Suggestion:* use a "while" loop to step through the course and logic statements to start or stop the vehicle as dictated by the "event code" column of data

# roaddata.txt format

| Distance [km] | Grade [°] | Speed [km/h] | Event Code | Time Duration, [s] |
|---|---|---|---|---|
| 0 | 0 | 48.4 | 0 | 0 |
| 10.0 | 0 | 72.5 | 0 | 0 |
| 21.0 | 0 | 72.5 | 0 | 0 |
| 39.0 | -0.2 | 48.4 | 0 | 0 |
| 125.0 | 0 | 32.2 | 1.0 | 10.0 |
| 200.0 | -5.0 | 32.2 | 0 | 0 |
| 250.0 | 0 | 0 | 2.0 | 0 |

# Event Code Definitions

**`if`** the event code value, **`ecv== 0`**,

  then the vehicle continues for the specified time
  duration

**`if ecv==1`**,

  then the vehicle should stop for the specified time
  duration

**`if ecv==2`**,

  then the vehicle has reached the end of the course

# Simulation Test Parameters

```
cd=0.095;        %Drag coefficient
m=363;           %Mass, [kg]
meff=1.03*m;     %Effective mass, [kg]
mu1=.004;        %Coefficients of rolling
mu2=.0001;       %resistance
p=101.3;         %Pressure, [kPa]
tc=20;           %Temperature, [C]
```

# Using MATLAB `while` Loops

- A `while` loop might be used to exectue a set of commands recursively when you are unsure how many times the loop needs to be executed.

- In the following example, time is steadily increasing until the distance x=10 is reached, but assuming we don't know how long this takes, we can't assign an endopint in a for loop *(see next slide)*

# while Example I

```
x=0;
v=0;
t=0;
tstep=1;
accel=1;
while x < 10
    x= x + v*t + (1/2)*accel*t^2;
    v= v + accel*tstep;
    t= t + tstep;
end
```

# **while** Example II

```
i=1;
x(i)=0;
v(i)=0;
t(i)=0;
tstep=1;
accel=1;
while x(i) < 10
    x(i+1)= x(i) + v(i)*t(i) + (1/2)*accel*t(i)^2;
    v(i+1)= v(i) + accel*tstep;
    t(i+1)= t(i) + tstep;
    i= i+1;
end
```