**ChE 310 Problem Set 10 Due Wed 4/17/19**

Collect all m-files in a single .zip file and upload the .zip file to the course webpage by midnight on Wednesday, April 17, 2019. Please note any collaborations in comments. Each student must upload their own unique copy of the work.

**10\_1 Derivatives and noisy data.**

A jet fighter is landing on an aircraft carrier runway. *Arresting gear* is used to help quickly decelerate the plane on the short runway. However, we need to ensure the deceleration is safe. For the pilots’ comfort, we assume that 5 *g* is a reasonable limit. (*g* = 9.81 m/s2)

Our engineers have assured us that the arresting gear provides a perfectly constant force, and therefore a perfectly constant deceleration. We perform a simple experiment, in which several observers note the position of the jet (x) after a certain time (t). Since we’re doing this by hand, there is a certain amount of error associated with the measurements.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| t (s) | 0 | 0.25 | 0.50 | 0.75 | 1.00 | 1.25 | 1.50 | 1.75 | 2.00 | 2.25 |
| x (m) | 0 | 19 | 36 | 53 | 66 | 74 | 82 | 91 | 95 | 96 |

1. Keeping in mind that velocity is equal to and acceleration is , numerically calculate the velocity and deceleration experienced by the plane at each time.
2. With this method of calculating derivatives, at what times will the deceleration exceed the 5 *g* limit?
3. If the engineers are correct (and we’ll assume they are ☺), then regression can be used to fit the (t,x) data to a quadratic model. Perform this regression, and determine the constant deceleration that the plane actually experiences according to the quadratic model. Does this actually exceed the 5 *g* safety limit?
4. On a 1x3 subplot, plot: (i) x vs. t, (ii) vs. t, and (iii) vs. t. For each subplot, include both the data calculated in (A) and the corresponding curves from the fitted function calculated in (C). This demonstrates how much the slight measurement errors affect our deceleration calculations, since we expected the deceleration to be perfectly constant!

**10\_2 2-D Integration**

Consider the following temperatures measured on a two-dimensional plate.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |
|  | 100.00 | 90.00 | 80.00 | 70.00 | 60.00 |
|  | 85.00 | 64.49 | 53.50 | 48.15 | 50.00 |
|  | 70.00 | 48.90 | 38.43 | 35.03 | 40.00 |
|  | 55.00 | 38.78 | 30.39 | 27.07 | 30.00 |
|  | 40.00 | 35.00 | 30.00 | 25.00 | 20.00 |

Use an integration method of your choice to determine the average plate temperature.

**10\_3** Solve problem 19.22 from the text.

**10\_4** Solve problem 21.25 from the text.

**10\_5** Solve problem 21.29 from the text.

**GROUP CREDIT –** Make sure to collaborate on Slack. Jared will be assigning points based on how you are interacting together.