MA 131 Calculus I – Written Assignment 1 Solutions

Here is a reminder of the criteria for these written assignments, as taken directly from page 3 of your course syllabus – unfortunately, I fear some of you had not reviewed these criteria before submitting your homework.

> (3) On several occasions during the semester, you will be required to submit SOLUTIONS to some selected problems of interest. A SOLUTION is not simply the answer, it is a complete explanation that clearly shows the process to determine the answer. These submissions will be graded based on the quality of the SOLUTION, not simply the correctness of the answer. These grades, along with the grades from WebAssign, will determine your overall score for homework in this course.

1. $\lim\limits_{d \to 0} \mathrm{err}(d) = \lim\limits_{d \to 0} 25\left(10^d - 1\right).$ This limit can be evaluated simply by substituting $d = 0$, which yields $25\left(10^0 - 1\right) = 25(0) = 0$. **[6 pts]**

    This <u>does</u> make sense, since if the initial angle of trajectory has no error (it is the "perfect" launch angle), then the spacecraft will hit its target precisely (or it will "miss" the target by *zero miles*). **[6 pts]**

2. Again, we can simply evaluate this limit by substitution, which gives us the following:
 $\lim\limits_{d \to 0.002} \mathrm{err}(d) = 25\left(10^{0.002} - 1\right) = 25(1.004615790278395 - 1) \approx 0.1154$. **[6 pts]**
    So, if our launch angle is off by an angle <u>*near to*</u> 0.002°, our target will be missed by a distance close to 0.1154 mile. Imagine, we're over a tenth of a mile from our target for such a slight error at launch! **[6 pts]**

3. To be technical, we should consider that our error function must be between –0.1 and 0.1 miles. *(Most of you weren't "technical," so I was lenient with the negative consideration.)* To find possible values of d, we do the following: $-0.1 \le 25\left(10^d - 1\right) \le 0.1$. We solve this, getting
    $\dfrac{-0.1}{25} \le 10^d - 1 \le \dfrac{0.1}{25} \Rightarrow -0.004 \le 10^d - 1 \le 0.004 \Rightarrow 0.996 \le 10^d \le 1.004$. Taking the log of all three parts, we find $\log 0.996 \le d \le \log 1.004 = -0.00174 \le d \le 0.0017337$. Thus, any angle that is within ~0.00174° of "perfect" will be satisfactory. **[12 pts]**

4. I will plot this result using Matlab. Not only am I graphing the function $\mathrm{err}(d) = 25(10^d - 1)$, from $d = -0.002$ to $d = 0.002$, but I'm also graphing the horizontal lines $y = 0.1$ and $y = -0.1$ so we can see where the desired accuracy would be lost. Further, I'm graphing the two vertical lines at the values determined from question 3, and the graph confirms our answer to part 3, as requested. *Note that the scale on the horizontal axis is multiplied by a factor of 10^{-3}.* **[12 pts]**
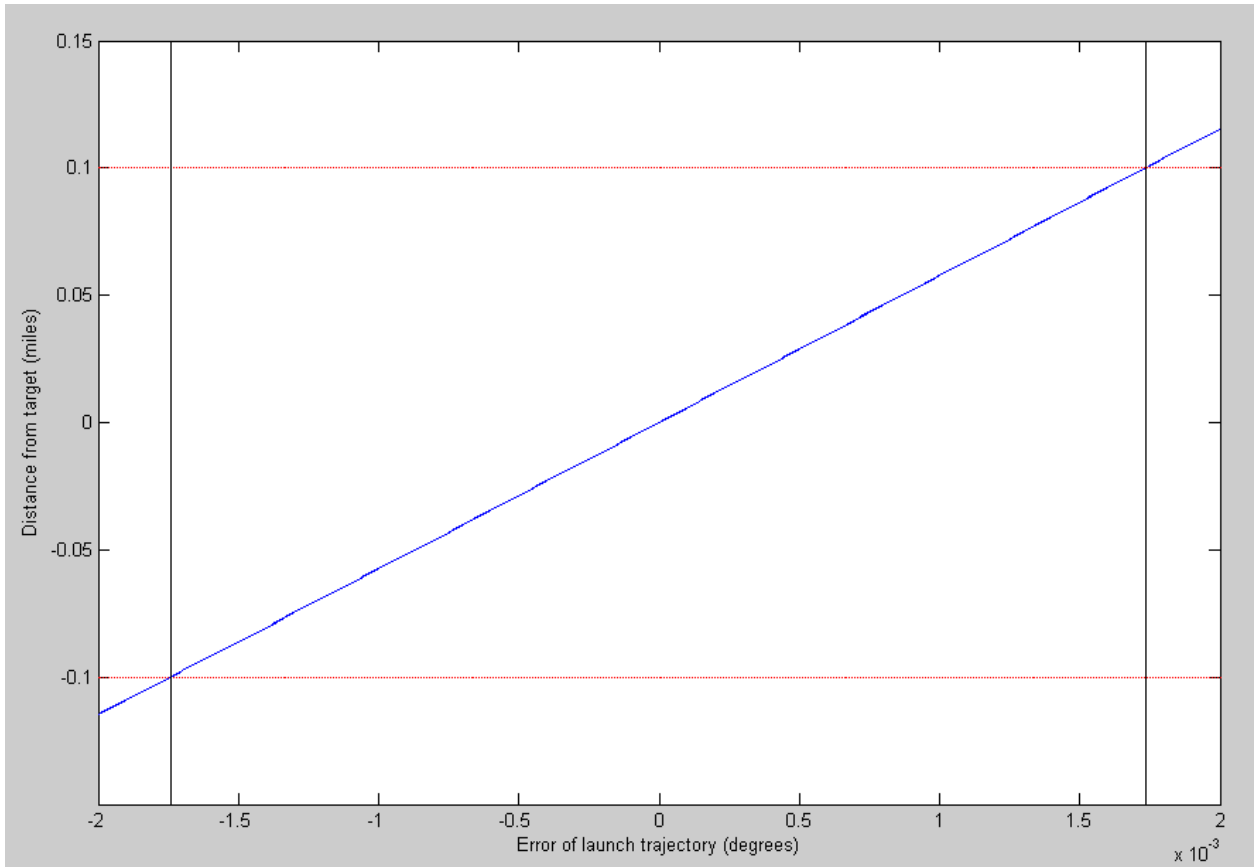
Note that this graph is not linear as it appears. If we graphed it on a larger domain, we'd see that its shape is of exponential nature, as we would expect from its equation.

The last 2 pts are for general neatness and presentation of your submission.