

**Class Problems and Homework**  
Physics 403: Mathematical Methods  
February 11, 2008

In Class Problem: Consider the following problem from standard physics books.

*Two trains, each having a speed of 30 km/h, are headed at each other on the same straight track. A bird that can fly 60 km/h flies off the front of one train when they are 60 km apart and heads directly for the other train. On reaching the other train, it flies directly back to the first train, and so forth. What is the total distance the bird travels?*

- First, determine how long it takes for the trains to collide, then answer the above question by using  $D = vt$  for the bird.
- For this bird, solve for the time it takes for the first three legs of the trip. You will see that the time for the  $n$ th passage is given by

$$t_n = 2 \left( \frac{1}{3} \right)^n .$$

- Write the total time of flight as a sum.
- Perform the Taylor series expansion of  $f(x) = 1/(1 - x)$  about  $x = 0$ , and write the series as a sum. Compare this with what you got above.
- Determine the total time of flight of the bird by performing the sum.

Homework:

1. Write out the first three terms in the Taylor series expansions about  $x = 0$  and  $x = a$  for
  - (a)  $\sin x$ ,
  - (b)  $\cos x$ ,
  - (c)  $e^x$ ,
  - (d)  $1/x$ ,
  - (e)  $\ln x$
  - (f)  $(1 + x)^k$ .
2. Compute  $\sin(\theta)$  for  $\theta = 0.4$  rad using the Taylor series. How many terms in the Taylor series do you need before your answer is accurate to 1%?
3. Complete problems 1.136 and 1.137 in the book.