MTH 308: Numerical Analysis & Scientific Computing I
Department of Mathematics and Statistics
Indian Institute of Technology - Kanpur — January 10, 2019

Lab 1

Steps you should follow :

1. Start a Matlab session by typing

   ```
   $ matlab &
   ```

   at the command prompt.

2. In the Matlab command window, type

   ```
   >> diary lab1_ID
   ```

   where ID stands for your roll number. For example, if your roll number is 12345, then the command will be `diary lab1_12345`; if your roll number is 123456, then the command will be `diary lab1_123456`. This will create a file named `lab1_ID` in the present working directory.

3. Do your lab assignments; once done type

   ```
   >> diary off
   ```

4. Attach this file (that is, `lab1_ID`) and any other matlab code file that you may have created for the labwork in an **email with subject Lab1-ID** and send it to

   mth308.iitk@gmail.com

   before the end of the lab session, that is, by 3:50 pm. Note that **late submissions will not get any credit**.

I. Write a probram to compute the absolute and relative errors in Sterling approximation

$$n! \approx \sqrt{2\pi n}(n/e)^n$$

for $n = 1, \ldots, 10$. Does absolute error grow or shrink as n increases? Does relative error grow or shrink as n increases?

II. Consider using the Taylor formula for e^x to evaluate e^{-5} :

$$e^x \approx 1 + \frac{x}{1!} + \frac{x^2}{2!} + \cdots + \frac{x^n}{n!}.$$

Compare your approximations for $n = 5, 10, 15, 20, 25, 30, 35, 40, 45, 50$, with the value that Matlab's `exp` function returns. What do you see? Explain your results.

III. Write a program to generate the first n terms in the sequence given by the difference equation

$$x_{k+1} = 2.25x_k - 0.5x_{k-1},$$

with starting values

$$x_1 = \frac{1}{3} \quad \text{and} \quad x_2 = \frac{1}{12}.$$

Use $n = 60$ and make a semilog plot of the values you obtain as a function of k (that is, plot k on x-axis and $\log_{10}(x_k)$ on y-axis while k ranges from 1 to 60). The exact solution of the difference equation is given by

$$x_k = \frac{4^{1-k}}{3}.$$

Does your graph confirm this theoretically expected behavior? Can you explain your results?