MAE 8 - Spring 2022
Homework 6

Instructions: Follow the homework solution template. Put all answers in a MATLAB script named **hw6.m**. For this homework, you will need to submit multiple files. Create a zip archive named **hw6.zip**. The zip archive should include the following files: **hw6.m** and **stringA.mat**. Submit **hw6.zip** in CANVAS before 10 PM on Sunday 5/15/2022. Use double precision unless otherwise stated.

Problem 1: Use **for loop** or **nested for loops** to evaluate the following expressions. Here, $\sum$ denotes summation and $\prod$ denotes product.

(a)

$$\sum_{n=1}^{40} \frac{2^n}{n!}$$

Put the answer into **p1a**. Hint: The answer is approximately $e^2 - 1$.

(b)

$$\sum_{m=0}^{40} \sum_{n=0}^{40} \frac{1}{3^{m+n}}$$

Put the answer to **p1b**. Hint: The answer is approximately 9/4.

(c)

$$\sum_{m=0}^{40} \sum_{n=0}^{m} \frac{1}{3^{m+n}}$$

Put the answer to **p1c**. Hint: The answer is approximately 27/16.

(d)

$$\sum_{l=1}^{40} \sum_{m=1}^{40} \sum_{n=1}^{40} \frac{1}{2^l 2^m 2^n}$$

Put the answer to **p1d**. Hint: The answer is approximately 1.

(e)

$$\sum_{l=1}^{5} \sum_{m=l}^{5} \sum_{n=l}^{m} 1$$

Put the answer to **p1e**.

(f)

$$\prod_{n=1}^{1000} \frac{4n^2}{4n^2 - 1}$$

Put the answer to **p1f**. Hint: The answer is approximately $\pi/2$.

Problem 2: In the following inequality equations, n is a positive integer. Use **while** loop to find the smallest value of **n** that satisfies the equations.

(a)

$$\frac{e}{(n+1)!} \leq 10^{-7}$$

Put the answer into **p2a**.

(b)

$$2^{n+1}(n+1) \geq 10^{7}$$

Put the answer into **p2b**.

Problem 3: A ball is released from a 10 m high roof and bounces three quarters as high on each successive bounce. After traveling a total of 59.99 m (up and down motion), how many times did the ball bounce? Put the answer in **p3a**. What is the height of the most recent bounce? Put the answer in **p3b**. Use **while** loop.

Problem 4: MATLAB treats a string as a vector of characters. For example, if stringA = 'Test', then stringA(1) = 'T', stringA(end) = 't' and length(stringA) = 4. In this exercise, you will use **for** loops and **switch** statements to examine a string. Download the file **stringA.mat** from CANVAS and load it into MATLAB. The file contains a string named **stringA**.

(a - c) How many times do the substrings **'how'**, **'are'**, and **'for'** appear in **stringA**? Put the answers into **p4a**, **p4b**, and **p4c**, respectively.

(d - f) How many times do the substrings **'many'**, **'time'**, and **'loop'** appear in **stringA**? Put the answers into **p4d**, **p4e**, and **p4f**, respectively.

Problem 5:

(a, b) The following series can be used to approximate the value of π:

$$\pi \approx 4\sum_{n=0}^{k}\frac{(-1)^n}{2n+1}.$$

where k is a positive integer. As k increases, the approximate value of π converges toward the true value. Find the smallest value of k such that the absolute error is less than 10^{-5}. Here, the absolute error is defined as the absolute difference between the approximate value and the MATLAB built-in value (i.e. **pi**). Put the approximate value of π in **p5a** and the value of k used to get the approximation in **p5b**.

(c, d) Repeat parts (a, b) with the following expression for π:

$$\pi \approx \sqrt{12}\sum_{n=0}^{k}\frac{(-3)^{(-n)}}{2n+1}.$$

Put the approximate value of π in **p5c** and the value of k used to get the approximation in **p5d**.

(e) Which series converges faster? Give answer in **p5e = 'The series in part ... converges faster'**.