

MATH609-600

Programming Assignment #1

Fall, 2015

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1 Problem Specifications

The computational exercises explore the applicability of the methods to compute the numerical solutions of linear systems.

1.1 Exercise 1: System with a Tridiagonal matrix

The approximate solution of the given linear system is computed and then compared with the exact solution.

1.2 Exercise 2: Approximation of 2D Elliptic equation

A 5-point finite difference formula is used to model the two-dimensional elliptic equation. The approximate solution is computed by applying the given boundary conditions.

1.3 Exercise 3: Hilbert matrix test

The versatility of the method developed is tested on an ill-conditioned matrix.

2 Preliminaries

The exercises in this programming assignment utilize the row-based Doolittle Algorithm for LU Factorization where the diagonal elements of the lower triangular matrix L are set to 1. The solution vectors are then found by completing the LU Factorization process.

3 Computational Results

3.1 Exercise 1: System with a Tridiagonal matrix

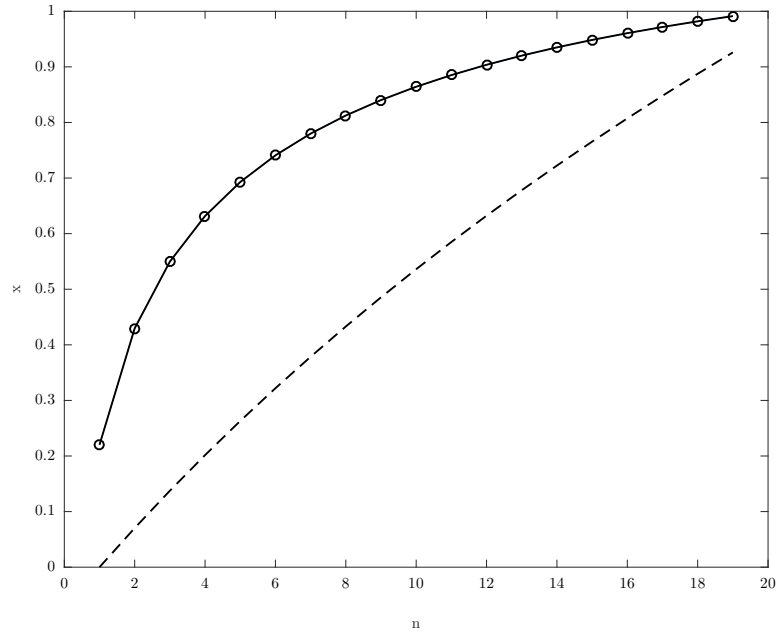


Figure 1: Approximate solution of FVM based linear system at $n = 19$

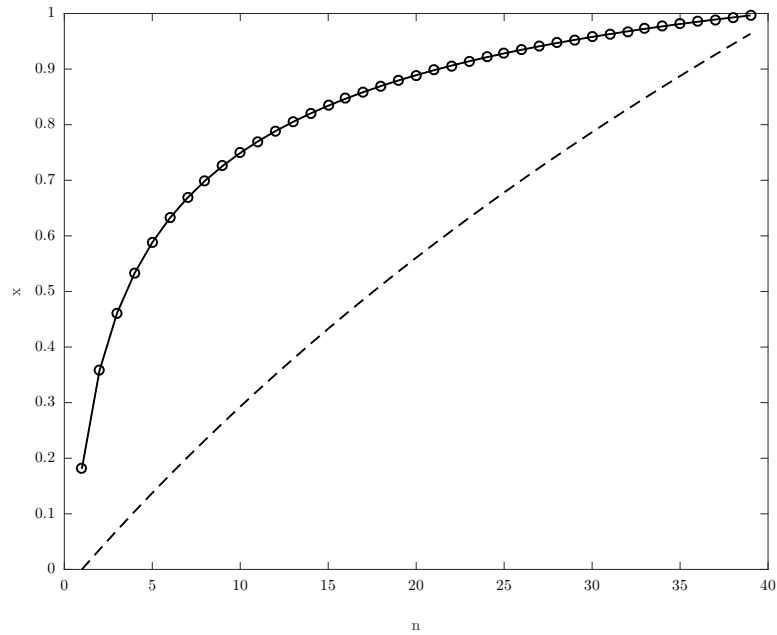


Figure 2: Approximate solution of FVM based linear system at $n = 39$

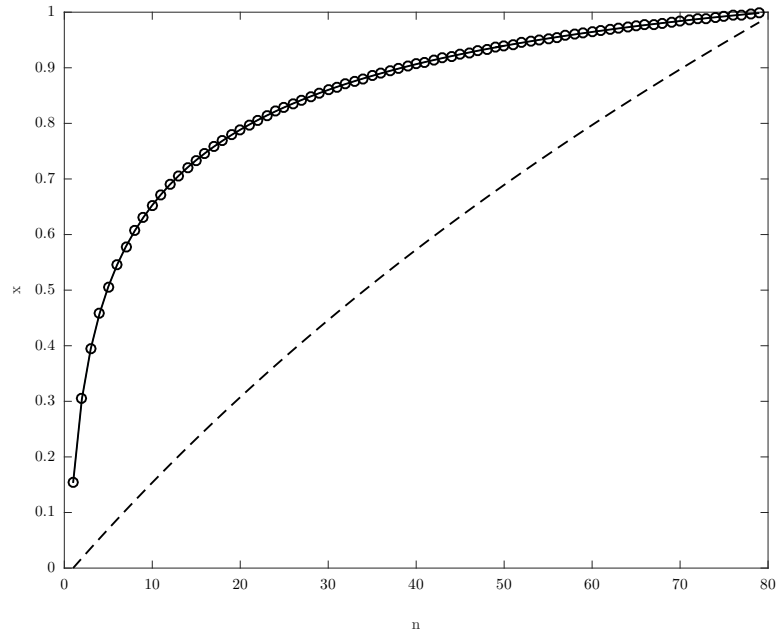


Figure 3: Approximate solution of FVM based linear system at $n = 79$

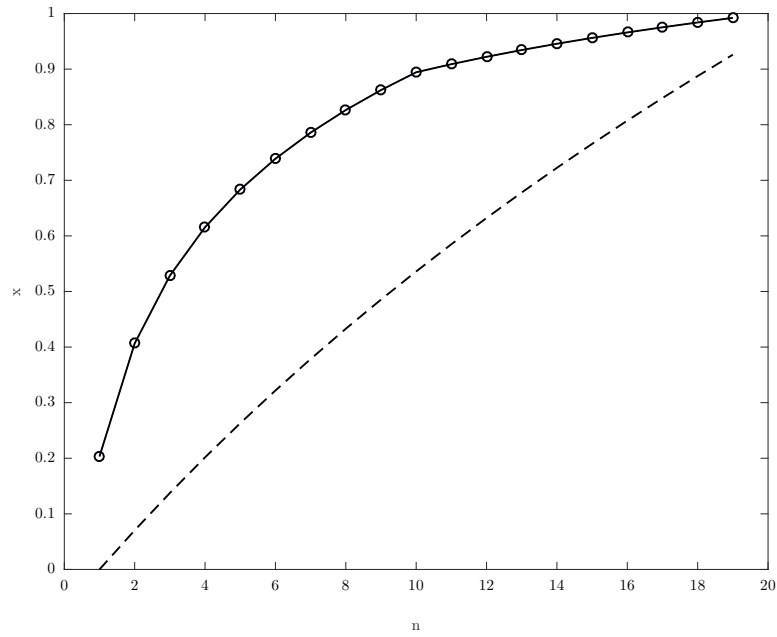


Figure 4: Approximate solution of FVM based linear system at $n = 19$ and $K = 2$

3.2 Exercise 2: Approximation of 2D Elliptic equation

3.3 Exercise 3: Hilbert matrix test

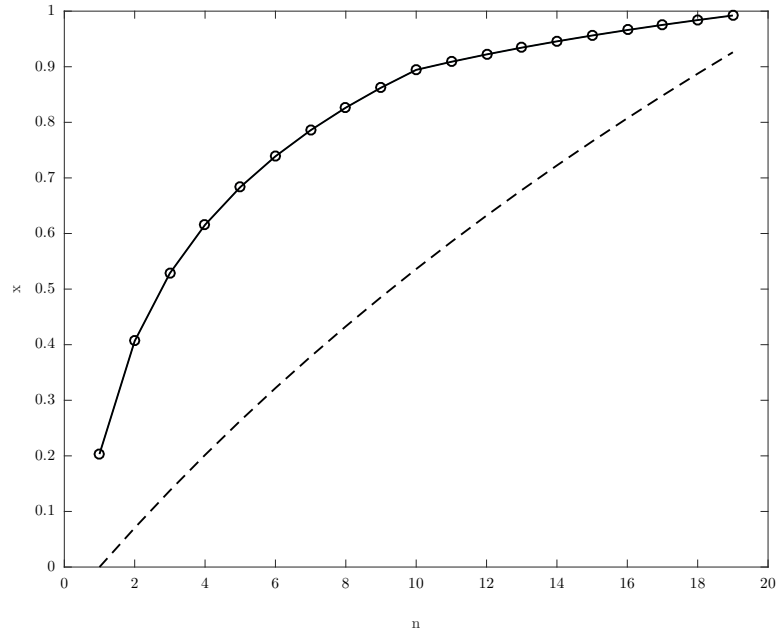


Figure 5: Approximate solution of FVM based linear system at $n = 19$ and $K = 5$

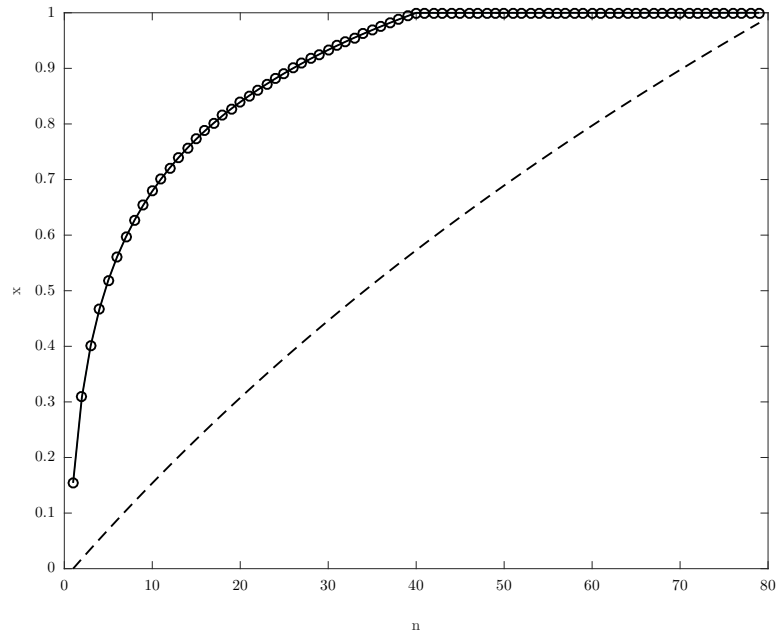


Figure 6: Approximate solution of FVM based linear system at $n = 79$ and $K = 1000$

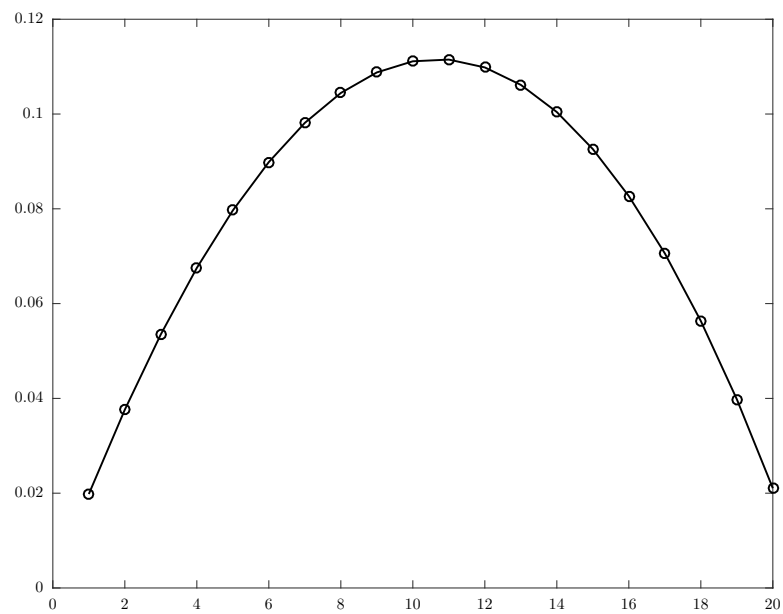


Figure 7: Approximate solution of 5-point elliptic equation at $n = 20$

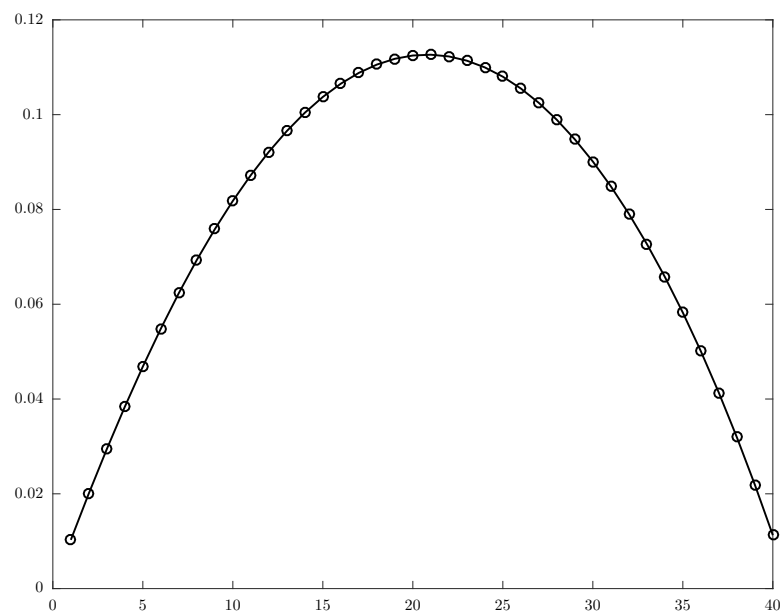


Figure 8: Approximate solution of 5-point elliptic equation at $n = 40$

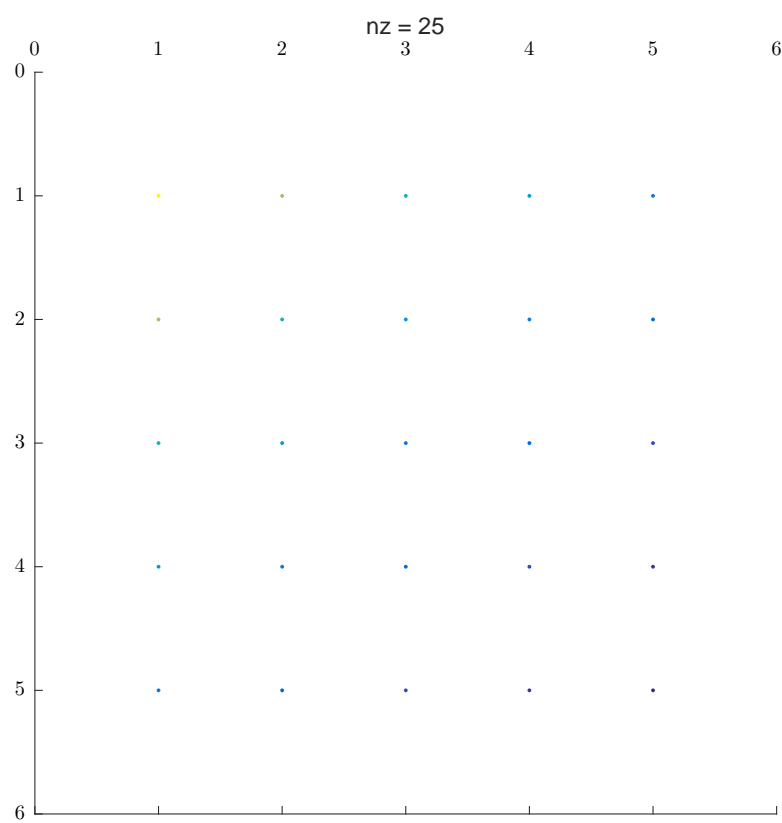


Figure 9: Matrix at $n = 5$

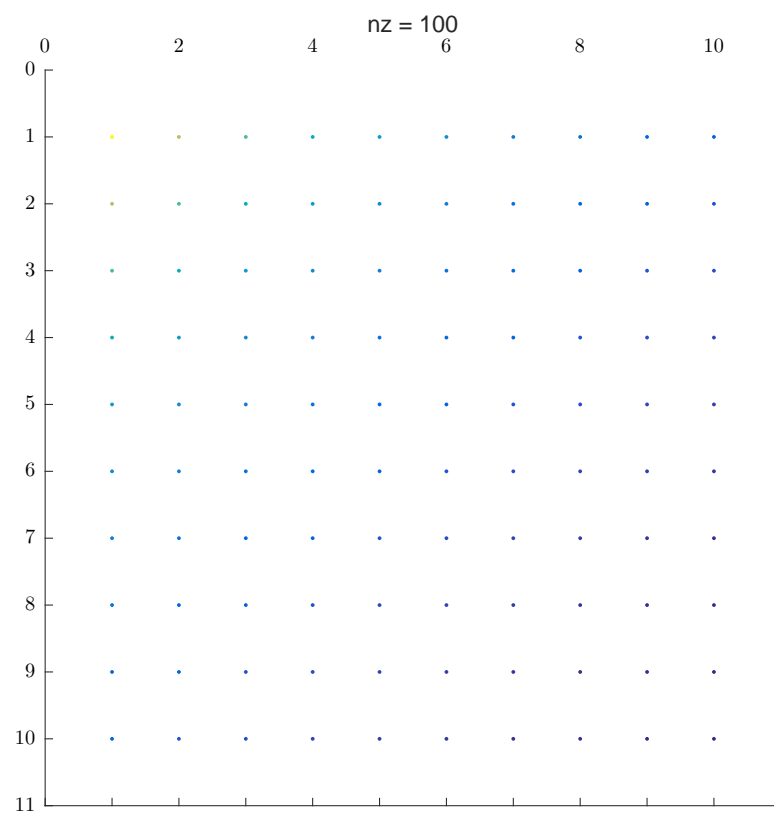


Figure 10: Matrix at $n = 10$

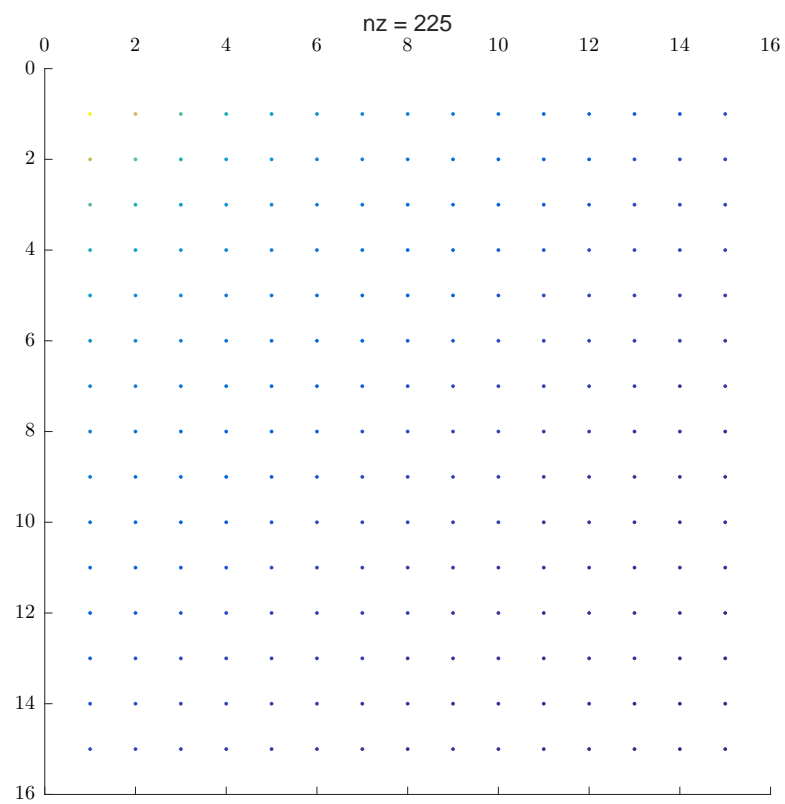


Figure 11: Matrix at $n = 15$

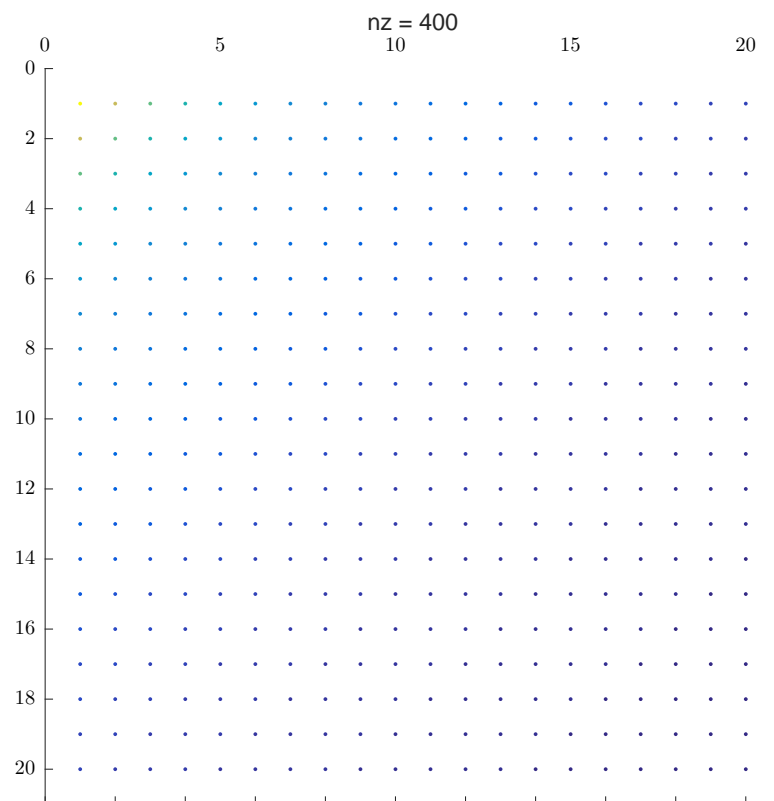


Figure 12: Matrix at $n = 20$

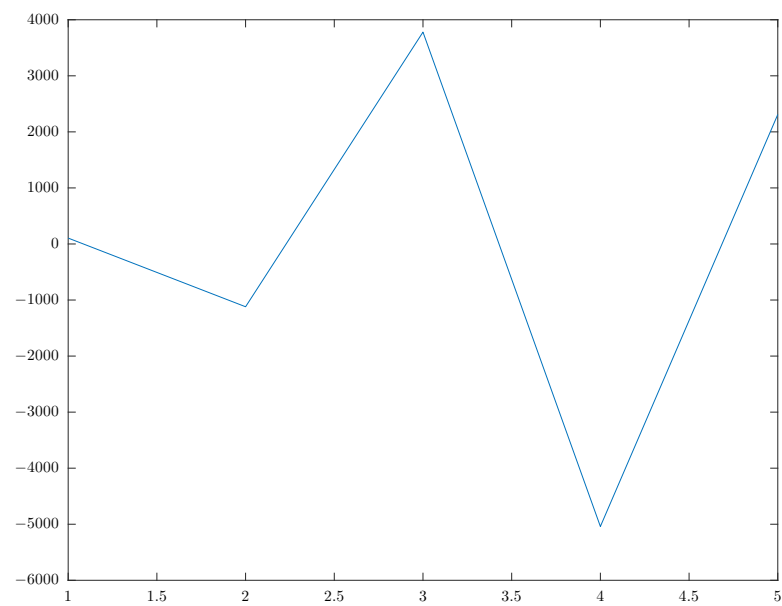


Figure 13: Solution at $n = 5$

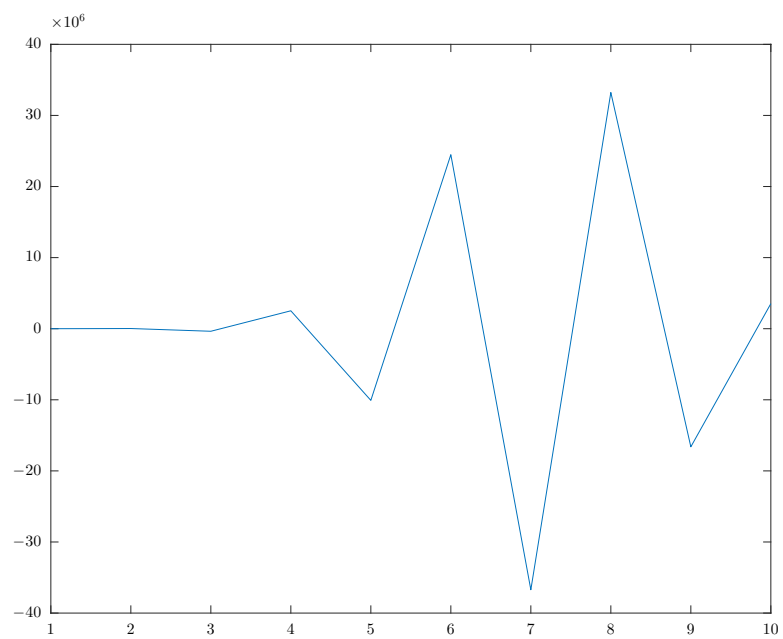


Figure 14: Solution at $n = 10$

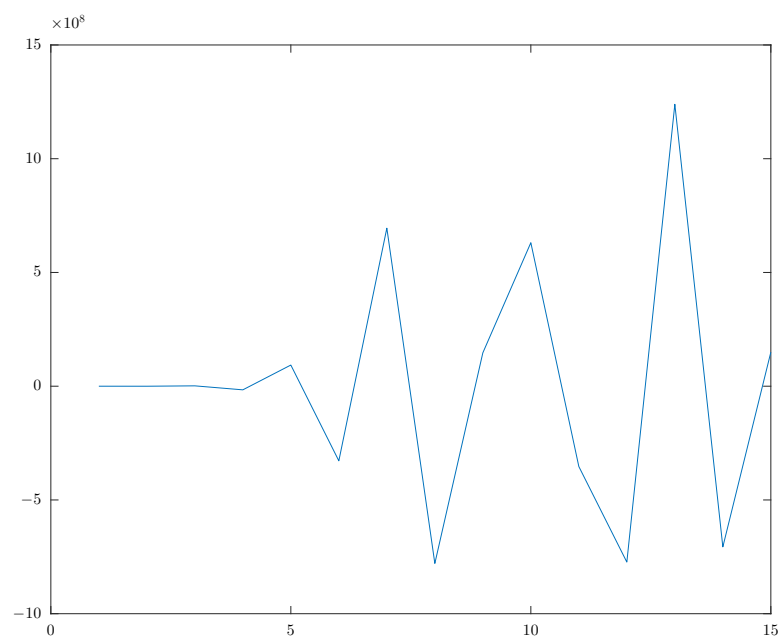


Figure 15: Solution at $n = 15$

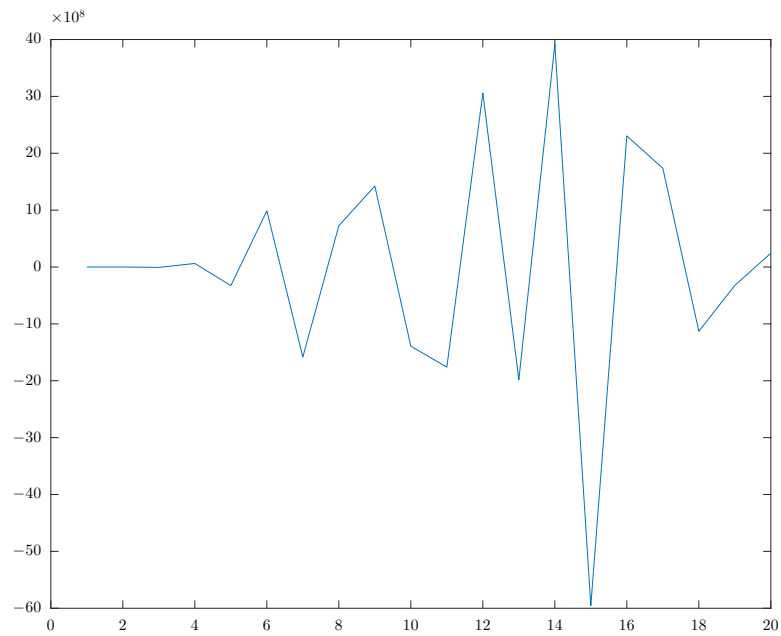


Figure 16: Solution at $n = 20$

As can be seen, the solution becomes larger and diverges. Hence the system outputs a poor result.