Norwegian University of Science and Technology
Department of Mathematics

MA2501 Numerical Methods
Spring 2014

Exercise set 2

$\boxed{1}$ Solve the linear systems in exercise set 1, task $\boxed{4}$, using Gaussian elimination with scaled partial pivoting. Write down all row interchanges.

$\boxed{2}$ **Cf. Cheney and Kincaid, Exercise 2.2.24**

Solve the following systems using Gaussian elimination without pivoting, with partial pivoting, with scaled partial pivoting, and with complete pivoting, carrying only four significant digits. Also, find the true solution:

a)

$$\begin{aligned} 0.004000x + 69.13y &= 69.17, \\ 4.281x - 5.230y &= 41.91. \end{aligned}$$

b)

$$\begin{aligned} 30.00x + 591400y &= 591700, \\ 5.291x - \quad 6.130y &= \quad 46.78. \end{aligned}$$

$\boxed{3}$ Assume that on a given computer it takes about 0.05 seconds to solve a linear system in 1000 variables using Gaussian elimination with scaled partial pivoting. Estimate how long the solution of a system in 5000 or 10000 variables will take.

Verify your estimations in MATLAB using the built-in solver for linear systems (i.e., the command \ ).

MATLAB-remarks

- You can measure the time some operation in MATLAB takes using the commands `tic` (for starting a timer) and `toc` (for stopping).
- For the numerical experiment you can, for instance, create random vectors and matrices using the command `rand`.
- In case you have a slower computer, either use smaller linear systems for this experiment or make sure that you have an interesting and *long* book with you.

$\boxed{4}$ Implement in MATLAB Gaussian elimination both without pivoting and with scaled partial pivoting. Test your functions on the linear systems of exercise set 1.

5 **Cf. Cheney and Kincaid, Computer Exercise 2.2.14.**

The determinant of a matrix can be easily computed with an algorithm for the forward elimination part of Gaussian elimination. This is due to the facts that:

- The determinant of a triangular matrix is the product of its diagonal entries.
- The determinant of a matrix does not change when the multiple of a one row is added to another row.
- If two rows of a matrix are exchanged, then the determinant changes sign.

Now note that forward elimination can be interpreted as a method for reducing a matrix to (upper) triangular form by only exchanging rows and adding multiples of one row to another row.

Write a function in MATLAB for the computation of the determinant of a square matrix and test the function on the matrices of the linear systems of exercise set 1.