University of Batna 2
Faculty of Mathematics and computer science
Department of computer science

Numerical Methods Practical Works

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Practical Work "03"

MATLAB Exercises

Exercise 01

Create a vector that goes at equal steps from −2 to +2 containing 50 components.

Exercise 02

1. Using the help command, find what does the reshape command do?
2. Create the following matrix using one MATLAB line of code and the reshape command.

$$M = \begin{pmatrix} 1 & 9 & 17 \\ 3 & 11 & 19 \\ 5 & 13 & 21 \\ 7 & 15 & 23 \end{pmatrix}$$

Exercise 03

Find and display in a vector all integers between 1 and 1000 which divide by 37. Propose at least two different ways to solve this problem.

Exercise 04

Fibonacci numbers form a sequence starting with 0 followed by 1. Each subsequent number is the sum of the previous two. Hence the sequence starts as 0, 1, 1, 2, 3, 5, 8, 13, ….

Write a non-recursive MATLAB function to calculate the Fibonacci sequence and return the number with a specified index.

Exercise 05

Write a recursive MATLAB function to calculate the Fibonacci sequence and return the number with a specified index.

Exercise 06

Write a MATLAB program (function) to calculate the trace of a square matrix A of order n>0.

The trace of a matrix is given by: $tr(A) = a_{11} + a_{22} + \cdots + a_{nn}$.

Exercise 07

Write a MATLAB program to calculate the determinant of a matrix A of order n>0.
The determinant of a matrix is given by: $\det(A) = \sum_{j=1}^{n}(-1)^{i+j} \times a_{ij} \times \det(A_{ij})$.

Exercise 08

Write a MATLAB program that allows you to verify the existence of the inverse of a matrix A then calculate this inverse if it exists.
The inverse of a matrix is given by: $A^{-1} = \frac{1}{\det(A)} \times C^T$
With $C = (-1)^{i+j}A_{ij}$ and A_{ij} is the determinant of the matrix of size $(n-1) \times (n-1)$ obtained from A by deleting the i^{th} row and j^{th} column of A.
Use the previous function to calculate the determinant.

Exercise 09

Write a MATLAB function that calculates the $\|v\|_1$ and $\|v\|_2$ and $\|v\|_\infty$ norms of a given vector v.
Where: $\|v\|_1 = \sum_{i=1}^{n}|v_i|$. $\|v\|_2 = (\sum_{i=1}^{n}|v_i|^2)^{\frac{1}{2}}$. $\|v\|_\infty = \max_i |v_i|$

Exercise 10

Write a MATLAB program that calculates the $\|A\|_1$ and $\|A\|_F$ and $\|A\|_\infty$ norms of a given matrix A.
Where: $\|A\|_1 = \max_j \sum_i |a_{ij}|$. $\|A\|_\infty = \max_i \sum_j |a_{ij}|$. $\|A\|_F = \sqrt{tr(A^T A)}$.
Use the trace function from exercise 6.

Exercise 11

Write a MATLAB program to solve a system of linear equations $Ax = b$ using Cramer's method.
The solution is given by the following formula: $x_i = {detA_i}/{detA}$ with A_i is a matrix obtained from A by replacing the i^{th} column of A with the vector b.

Exercise 12

Write a MATLAB program to solve a system of linear equations $Ax = b$ using Gauss's elimination.
The solution is given by:

$$
\begin{cases}
\text{At first step}\begin{cases} L_1^{(2)} \leftarrow L_1^{(1)} \\ L_i^{(2)} \leftarrow L_i^{(1)} - \alpha_{i1} L_1^{(1)} \text{ où } \alpha_{i1} = \dfrac{a_{i1}^{(1)}}{a_{11}^{(1)}} \end{cases} \\
\text{At } k^{th} \text{ step}\begin{cases} L_i^{(k+1)} \leftarrow L_i^{(k)}, 1 \le i \le k. \\ L_i^{(k+1)} \leftarrow L_i^{(k)} - \alpha_{ik} L_k^{(k)} \text{ où } \alpha_{ik} = \dfrac{a_{ik}^{(k)}}{a_{kk}^{(k)}}, k+1 \le i \le n. \end{cases}
\end{cases}
$$

Exercise 13

Write a MATLAB program to solve a system of linear equations $Ax = b$ using LU factorization. The solution is given by:

$$
\begin{cases}
l_{ii} = 1, 1 \le i \le n; \\
\text{first step}\begin{cases} u_{1j} = a_{1j}, 1 \le j \le n; \\ l_{i1} = \dfrac{a_{i1}}{a_{11}}, 2 \le i \le n; \end{cases} \\
k^{th} \text{ step}\begin{cases} u_{mj} = a_{mj} - \displaystyle\sum_{k=1}^{m-1} l_{mk} . u_{kj}, m \le j \le n \text{ and } 2 \le m \le n \\ l_{im} = \dfrac{(a_{im} - \sum_{k=1}^{m-1} l_{ik} . u_{km})}{u_{mm}}, m+1 \le i \le n \text{ and } 2 \le m \le n \end{cases}
\end{cases}
$$