LA1 - Version 2 - Exercise 1

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```
# initial setup
options(scipen = 999)
options(tinytex.verbose = TRUE)
library(matlib)
library(knitr)
library(rmarkdown)
library(quarto)
library(tinytex)
library(pandoc)
knitr::opts_chunk$set(echo=TRUE, message=FALSE, warning=FALSE, fig.width=6, fig.height=6)
```

Find all solution of systems of linear equations of the form Ax=b, where:

```
# enter variable (matrix) A in R matlib pkg
A <- matrix(
        c(-2, 1, 0,  2,
           3,-2, 0, -5,
          -2, 3, 2, 12,
           2,-2,-1, -7), 4, 4, byrow=TRUE)
```

```
# enter variable with right hand side vertical vector
b <- c(-3, 5, -3, 3)
```

Code the equation in R matlib (commented out):

```
Eqn(
    "\\mathbf{A} =",
     latexMatrix(A, matrix="bmatrix"),
     latexMatrix("x", nrow = 4, ncol=1),
     Eqn_hspace(mid='='),
     latexMatrix(matrix(b, ncol = 1))
)
```

Show equation (R's Latex output):

$$\mathbf{A} = \begin{bmatrix} -2 & 1 & 0 & 2 \\ 3 & -2 & 0 & -5 \\ -2 & 3 & 2 & 12 \\ 2 & -2 & -1 & -7 \end{bmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{pmatrix} = \begin{pmatrix} -3 \\ 5 \\ -3 \\ 3 \end{pmatrix}$$

Code equation solving:

```
Solve(A, b, fractions = TRUE)
```

Show the final result of the equation (not Latex, plain):

```
x1       + x4  =   1
  x2   + 4*x4  =  -1
    x3   + x4  =   1
            0  =   0
```

Show whole verbose solution, ie. each row operation, created by command `Solve`:

```
# thx to `verbose = TRUE` it outputs solution step by
# step with Gaussian elementary row operations
Solve(A, b, verbose = TRUE, fractions = TRUE)
```

```
##
## Initial matrix:
##      [,1] [,2] [,3] [,4] [,5]
## [1,] -2    1    0    2   -3
## [2,]  3   -2    0   -5    5
## [3,] -2    3    2   12   -3
## [4,]  2   -2   -1   -7    3
##
## row: 1
##
##  exchange rows 1 and 2
##      [,1] [,2] [,3] [,4] [,5]
## [1,]  3   -2    0   -5    5
## [2,] -2    1    0    2   -3
## [3,] -2    3    2   12   -3
## [4,]  2   -2   -1   -7    3
##
##  multiply row 1 by 1/3
##      [,1] [,2] [,3] [,4] [,5]
## [1,]    1 -2/3    0 -5/3  5/3
## [2,]   -2    1    0    2   -3
## [3,]   -2    3    2   12   -3
## [4,]    2   -2   -1   -7    3
##
##  multiply row 1 by 2 and add to row 2
##      [,1] [,2] [,3] [,4] [,5]
## [1,]    1 -2/3    0 -5/3  5/3
## [2,]    0 -1/3    0 -4/3  1/3
## [3,]   -2    3    2   12   -3
## [4,]    2   -2   -1   -7    3
##
##  multiply row 1 by 2 and add to row 3
##      [,1] [,2] [,3] [,4] [,5]
## [1,]    1 -2/3    0 -5/3  5/3
## [2,]    0 -1/3    0 -4/3  1/3
## [3,]    0  5/3    2 26/3  1/3
## [4,]    2   -2   -1   -7    3
##
##  multiply row 1 by 2 and subtract from row 4
##      [,1]  [,2]  [,3]  [,4]  [,5]
## [1,]    1 -2/3     0 -5/3   5/3
## [2,]    0 -1/3     0 -4/3   1/3
## [3,]    0  5/3     2 26/3   1/3
## [4,]    0 -2/3    -1 -11/3 -1/3
##
## row: 2
##
##  exchange rows 2 and 3
##      [,1]  [,2]  [,3]  [,4]  [,5]
## [1,]    1 -2/3     0 -5/3   5/3
## [2,]    0  5/3     2 26/3   1/3
## [3,]    0 -1/3     0 -4/3   1/3
```

```
## [4,]    0  -2/3    -1 -11/3  -1/3
##
##  multiply row 2 by 3/5
##      [,1]  [,2]  [,3]  [,4]  [,5]
## [1,]    1  -2/3     0  -5/3   5/3
## [2,]    0     1   6/5  26/5   1/5
## [3,]    0  -1/3     0  -4/3   1/3
## [4,]    0  -2/3    -1 -11/3  -1/3
##
##  multiply row 2 by 2/3 and add to row 1
##      [,1]  [,2]  [,3]  [,4]  [,5]
## [1,]    1     0   4/5   9/5   9/5
## [2,]    0     1   6/5  26/5   1/5
## [3,]    0  -1/3     0  -4/3   1/3
## [4,]    0  -2/3    -1 -11/3  -1/3
##
##  multiply row 2 by 1/3 and add to row 3
##      [,1]  [,2]  [,3]  [,4]  [,5]
## [1,]    1     0   4/5   9/5   9/5
## [2,]    0     1   6/5  26/5   1/5
## [3,]    0     0   2/5   2/5   2/5
## [4,]    0  -2/3    -1 -11/3  -1/3
##
##  multiply row 2 by 2/3 and add to row 4
##      [,1] [,2] [,3] [,4] [,5]
## [1,]    1    0  4/5  9/5  9/5
## [2,]    0    1  6/5 26/5  1/5
## [3,]    0    0  2/5  2/5  2/5
## [4,]    0    0 -1/5 -1/5 -1/5
##
## row: 3
##
##  multiply row 3 by 5/2
##      [,1] [,2] [,3] [,4] [,5]
## [1,]    1    0  4/5  9/5  9/5
## [2,]    0    1  6/5 26/5  1/5
## [3,]    0    0    1    1    1
## [4,]    0    0 -1/5 -1/5 -1/5
##
##  multiply row 3 by 4/5 and subtract from row 1
##      [,1] [,2] [,3] [,4] [,5]
## [1,]    1    0    0    1    1
## [2,]    0    1  6/5 26/5  1/5
## [3,]    0    0    1    1    1
## [4,]    0    0 -1/5 -1/5 -1/5
##
##  multiply row 3 by 6/5 and subtract from row 2
##      [,1] [,2] [,3] [,4] [,5]
## [1,]    1    0    0    1    1
## [2,]    0    1    0    4   -1
## [3,]    0    0    1    1    1
## [4,]    0    0 -1/5 -1/5 -1/5
##
##  multiply row 3 by 1/5 and add to row 4
##      [,1] [,2] [,3] [,4] [,5]
## [1,]  1    0    0    1    1
## [2,]  0    1    0    4   -1
```

```
## [3,]  0    0    1    1    1
## [4,]  0    0    0    0    0
##
## row: 4
## x1       + x4  =   1
##   x2   + 4*x4  =  -1
##     x3   + x4  =   1
##              0  =   0
```