General instructions for the computer lab

Students can work alone or in groups to complete the laboratory but *each student must write and submit their own files*. The lab has four parts that each require a file be submitted in Cambro before the deadline. Part 1 requires the submission of a MATLAB function named "myproblem.m". Part 2 requires the submission of a MATLAB function named "mygauss.m". Part 3 requires the submission of a MATLAB function named "mycheck.m". Part 4 requires the submission of a written lab report. The lab must be written in the student's own words and in the form of a PDF. In order to facilitate the correction, the filename of the report should include the student's name, for example "labreport_firstname_lastname.pdf".

The report must be submitted via Cambro no later than the 15th of February by 16:15. If the laboratory report is not satisfactory, a new report must be submitted by the 22nd of March by 16:15. There is a final opportunity to submit a lab report by the 26th of April at 16:15. If the report still does not pass, there is the opportunity to do another computer lab at the next time the course is given, but it will then be according to the instructions applicable at the time of the course (i.e., then it may be a new computer lab with other tasks to be solved).

Supervision in the computer room is offered on the 7th and 8th of February. Come well-prepared; it is recommended that you read the instructions for the lab report carefully and do some planning regarding the computer code and the analysis beforehand. You can also use the campus license for MATLAB to do the computer lab at another time. Read more about running MATLAB on a private computer at: https://www.umu.se/student/matematik-och-matematisk-statistik/matlab/.

Grading

The grades for the lab are either a passing G or a failing/incomplete U. To get a passing grade of G on the lab report all four parts must be satisfactorily completed and their files submitted to Cambro by the deadline.

1. The function `myproblem` should work as described in Part 1.
2. The function `mygauss` should work as described in Part 2.
3. The function `mycheck` should work as described in Part 3.
4. The written report should meet the specifications described in Part 4.

The written report should include clear writing and argumentation and be written in English if at all possible. The grading is not based on fluency in language but rather clarity of thought and communication. There should be evidence that the student thought critically about the assignment. Simple, short, and logical sentences are worth much more than complex, convoluted, and confusing sentences. Finally, one tip for the written report is to let someone else read your report and see if they understand it.

Computer lab assignment

Part 1: Creating a problem

Write a Matlab function called "`myproblem`" that takes as input two integers m and n (where $m \geq 2$ and $n \geq 2$) and returns as output an $m \times n$ matrix A and an $m \times 1$ vector b. For example:

```
>> m=3;
>> n=2;
>> [A,b]=myproblem(m,n)

A =

     5     1
     3     3
     3     5

b =

     11
     9
     11

>>
```

Note that the function does not need to return the same A and b each time it is called. It simply has to return a matrix and a vector that matches the size specifications.

Part 2: Solving the problem

Write a new Matlab function called "`mygauss`" that performs Gaussian elimination in order to solve a linear system of equations $Ax = b$. The function will take as inputs an $m \times n$ matrix A and an $m \times 1$ vector b. It will return as output the solution x which is an $n \times 1$ vector. The function must satisfy the following criteria:

1. The function must be called " `mygauss` ". Thus, to solve $Ax = b$, one simply needs to type `x=mygauss(A,b)` .
2. The function must perform Gaussian elimination and cannot rely on the Matlab backslash " `\` " command. The function cannot use something of the form `A\b` .
3. If there is no x that satisfies $Ax = b$ then `x=mygauss(A,b)` must return `x=-1` .

Here is an example of a call of the function using the output `A` and `b` from `myproblem(m,n)` above:

```
>> x=mygauss(A,b)

x =

    2.0000
    1.0000
```

Here is another example of a successful call of the function using the previously defined matrix `A` and a newly defined vector `c` in which there is no x that satisfies $Ax = c$:

```
>> c=[11;11;11];
>> x=mygauss(A,c)

x =

    -1
```

Part 3: Checking your solution

Write a new Matlab function called "`mycheck`" that takes in a $m \times n$ matrix `A`, a $m \times 1$ vector `b`, and a vector `x`. The function `mycheck` will evaluate whether or not the vector `x` satisfies $Ax = b$. If it does, then `mycheck(A,b,x)` will return a 1. If not, it will return a 0. Thus, if `x=mygauss(A,b)` did not return `x=-1` , then calling `y=mycheck(A,b,x)` should set `y` equal to 1 if `mygauss` works correctly.

Note that if `x=mygauss(A,b)` returns `x=-1` then immediately using `y=mycheck(A,b,x)` might return an error because `x` is not an $n \times 1$ vector but rather a 1×1 scalar. In this case your code should catch this error and return a `0` because `x` is not a solution. Hint: you can use the MATLAB commands `if`, `else`, `try`, `catch`, `size` to handle this error. To reiterate, if there is no solution to $Ax = b$ then `x=mygauss(A,b)` should return `x=-1` and then `y=mycheck(A,b,x)` should set `y` equal to 0.

Here are examples of successful calls of `mycheck` using the previously defined matrix `A` and the previously defined vectors `b` and `c`:

```
>> x=mygauss(A,b);
>> y=mycheck(A,b,x)

y =

    1

>> y=mycheck(A,c,x)

y =

    0

>> x=mygauss(A,c);
>> y=mycheck(A,c,x)

y =

    0
```

Part 4: Revealing your brilliance

The student should write five paragraphs reflecting critically on the computer lab assignment. There is no defined set of questions to answer or topics to discuss. Rather, the report is to highlight the individual thinking of the student and demonstrate that the student thought carefully about the assignment and Gaussian elimination as a tool for solving linear systems of equations. In terms of the writing, use complete sentences to clearly and simply convey ideas. Below are possible questions/topics that could be addressed in the lab report. Again, this is not a checklist but is simply to foster creativity.

1. Why did you chose the particular form of `myproblem`?
2. Did you search online for algorithms of Gaussian elimination? Were some websites/resources helpful? Were some confusing?
3. How does your function compare in speed to MATLAB's backslash command?
4. What aspect of this assignment was difficult or caused you to spend the most time?
5. How many computations do your functions do? Is there a way to do it faster or better?
6. How did you check your functions to make sure they were performing correctly?
7. Would this assignment been easier using another computer language?
8. Did this assignment help your understanding of Gaussian elimination?

Extra credit

Students can earn bonus points toward the final exam held on the 20th of February provided that they turn their computer lab report in by the deadline on the 15th of February. There will be a tournament held in which the different `myproblem` and `mygauss` functions are competed against one another. More points will be awarded to students whose `myproblem` function stumps the `mygauss` solver of other students but not their own. Students can also earn bonus points for a well-thought written lab report corresponding to Part 4.