

## Review of MATLAB

Observe that the final exam does not happen in a computer lab, but in a regular room. Without computer, the exam will not require the availability of Maple and MATLAB, but will be a bit more conceptual than otherwise. The exam is still open book and open notes. Calculators or laptop computers are not allowed.

1. Explain the difference between the `*` and `.*` operators.  
Give an example where the `*` must be used instead of the `.*` operator.  
Give an example where the `.*` must be used instead of the `*` operator.
2. Fermat's spiral is defined in polar coordinates by  $r = \sqrt{t}$ .  
Give the MATLAB commands to make a plot for  $t$  from 0 to 25.
3. Give the MATLAB commands to make a plot of the surface  $z = y^2 \cos(xy)$ , for  $x$  and  $y$  ranging between  $-\pi$  and  $+\pi$ .
4. In MATLAB we have seen three different situations where we encountered approximate data. For each such different situation, we processed the data differently. Describe briefly each situation and list the most important MATLAB command that was used in processing the approximate data.
5. The trapezoidal rule to approximate the definite integral of  $f(x)$  over  $[a, b]$  is defined as

$$\int_a^b f(x) dx \approx \frac{b-a}{2} (f(a) + f(b)).$$

- (a) Write an m-file to implement the function

```
function y = traprule(f,a,b)
% returns (f(a) + f(b))*(b-a)/2
```

- (b) Use `traprule` to approximate the integral of  $\cos(x)$  for  $x$  between  $\pi/4$  and  $\pi/2$ .  
(c) To extend the accuracy of the approximation, we can split the interval  $[a, b]$  in two and apply the trapezoidal rule to both halves. Give a recursive implementation of the following function:

```
function y = traprule(f,a,b,n)
% bisects the interval [a,b] n-1 times and applies the
% trapezoidal rule on each half.
```

6. Suppose we want to sample a signal  $f(t)$  for three seconds. The signal has a frequency of 10 oscillations per second. How many samples of  $f(t)$  should we take in the interval  $[0, 3]$  for a faithful representation of the signal? Give an example how you would test this in MATLAB, i.e.: make a signal which oscillates 10 times per second and plot it.
7. How would you in MATLAB define a permutation matrix  $P$  so that `P * [1 2 3 .. n]'` returns `[n .. 3 2 1]'`, for some number `n`? (*Hint*: take `n = 3` and generalize.)
8. Suppose an investor has a choice between three types of shares. Type A pays 4%, type B pays 6%, and type C pays 9% interest. The investor has \$100,000 available to buy shares and wants to maximize the interest, under the following constraints:
  - (i) no more than \$20,000 can be spent on shares of type C;
  - (ii) at least \$10,000 of the portfolio should be spent on shares of type A.
  - (a) Give the mathematical description of the optimization problem.
  - (b) Bring the problem into a form ready to call MATLAB's `linprog` command.

The questions above are just samples of the type of questions you may expect. Also review the homework assignments and quizzes. The experience gained in the project may also help you.

**FINAL EXAM is in Taft Hall 0219 on Tuesday 6 May 2003 from 1:00 till 3:00PM.**

In case of a scheduling conflict with another final exam, please let me know as soon as possible so we can schedule a makeup.

Observe the university rules concerning incompletes. An incomplete can only be granted if all of the following conditions are satisfied:

1. The student is in good standing and needs only a final exam to complete the course. In particular, this means that no midterms are skipped, attendance to the discussion sessions was documented by quiz scores, and all projects received a satisfactory grade.
2. Some event (for which adequate documentation can be provided) prevented the student from doing a makeup final exam.

Note that these rules are from the university, and that the administration needs to approve incompletes.