LINEAR AND POLYNOMIAL FUNCTIONS

COMPUTER SESSION B1

BACKGROUND

The goal of today's session is to understand what a function is, and the representation $y = m + k(x - a)$ of an *affine* (constant + linear) function. Recall the characteristic features of the *monomials* $f(x) = x^m$ with m a natural number, and what is a *polynomial*. Study in some detail *quadratic* polynomials, and *compositions* (sammansättningar) with affine functions.

PREPARATIONS

Start Matlab.

If you are working on the computers of the School of Chemical Engineering at Chalmers, then download the file `startmath.m` to your Matlab work directory (if you have not done this already). This file is available on the web page of this session under Programs and templates. Then type `startmath` at the Matlab prompt. This command sets the search path to the directories where the Mathematics Laboratory is kept.

If you are working on another computer, then download the file `MathematicsLaboratory.zip` to your Matlab work directory. This file is available on the web page of this session under Programs and templates. Unzip the file, it should create a directory guis in your Matlab work directory. At the Matlab prompt, type: `addpath guis`. You are now ready to use the Mathematics Laboratory.

Keep your AMBS book with you and open at the relevant chapters.

PROBLEMS

Problem 1 - Linear Functions. Give the command `open('RM+.fig')` (or possibly `open('RMplus')` if this doen't work) to open the Road Map to the Mathematics Laboratory. Enter the Graph Gallery, and then the exhibition of linear function by pressing the linears button. Alternatively you may enter this lab directly from RM+ by pressing the Linears button there, or directly from the matlab prompt by the command `open('GGlin.fig')`.

(1) Start by choosing $f(x) = m$ and changing m with the m-sliders. Then proceed by choosing $f(x) = m + kx$ and changing m and k. Note the way the graph and the equation changes.
(2) Create a linear function with a) $f(0) = 1$ and $f(2) = 0$, b) $f(0) = -.2$ and slope $= .6$, c) $f(-1) = 0$ and $f(1) = 1$.
(3) Proceed by choosing $y = m + k(x - a)$ and changing m, k and a. *Make absolutely sure you fully understand the role of each of the parameters m, a and k in this relation, which may well be the most important you will ever meet.*
(4) Create linear (affine) functions with a) $f(1) = 1$ and slope $= -.2$, b) $f(-1) = 0$ and $f(1) = 1$.
(5) Press the questions button and answer the listed questions.

Problem 2 - Polynomials. Now enter the polynomials gallery and lab, from the Graph gallery of directly from the RM+ map.

(1) First study monomials of the type x^m. What is the significance of a) odd/even m values of m, b) the size of m, c) the case $m = 0$.
(2) Recall that a function f is called odd if $f(-x) = -f(x)$ for all x, and even if $f(-x) = f(x)$ for all x. Are some of the functions x^m odd/even? Is the function $x^3 - 2x$ odd? Is the function $x^2 - x^3$ odd or even?
(3) Study the role of a and k in the relations $y = (x - a)^m$ and $y = k(x - a)^m$, respectively.
(4) Study polynomials by (from RM+) pressing the polynomials button and selecting $f(x) = k_0 + k_1x + k_2x^2 + ...$ and vary the multiples k_m by, for each selected m value, setting k_m with the k-slider or edit box.
(5) Create a polynomial of degree 2 with $f(0) = 0$ and maximum $= 1$ for $x = .4$.

(6) Create a polynomial of degree 3 with (approximately) a local min value at -1 for $x = 1$ and a local max value at 1 for $x = -.4$, by trial and error.
(7) Create a polynomial function of lowest possible degree with two (local maxima) and one (local) minima.
(8) Invent your own problems and experiment!!
(9) Reproduce the current plot in a new window by commands directly from the matlab prompt by first typing figure, to get a new window, then defining an appropriate range of x-values like `x = 0:0.01:1`, then the corresponding y-values, for example `y = 1 + 2 * x - 3 * x.^2`, and finally typing `plot(x,y)`.
(10) Check that you have reached the goals of the studio session!

Problem 3. If you have understood everything so far well, then practice some more on the basic programming concepts (expressions, functions, conditionals and loops) if you feel a bit unsure, it will be neccessary for the coming sessions.

SOLUTIONS

Make sure that you really try to solve each problem before looking at the solutions. Have you really tried to solve the problem or should you try again before looking at the solution?

The solutions are available on the web page of this session under *Solutions to problems*.

ABOUT

This Computer Session is part of the Body and Soul educational program. More information can be found at

`http://www.phi.chalmers.se/bodysoul/`

This Computer Session is maintained by Johan Jansson (johanjan@math.chalmers.se).