Aschaffenburg University of
Applied Sciences
Faculty for Engineering
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Numerical Methods
and Simulation
Module MT 03
Winter term 2015/16

Example questions for an exam

on ... January 2016

Personal details[1]:

Immatriculation number:												

First and last name:	

Remarks:

(1) The duration of the exam is 90 minutes.

(2) Be aware that you may find a later question easier than an earlier one.

(3) If not stated otherwise a subquestion is valid three points. Full score is only awarded if and only if all correct answers are given and no wrong answer is given.

(4) Please use a black or blue pen for your answers. Pencil will not be accepted.

(5) The use of any electronic device except a non-programmable calculator is not permitted. Please switch them off.

(6) No materials other than one sheet (two pages) of hand-written notes are permitted.

(7) You are free to answer all questions in English, German or any commonly understandable mix of both languages.

Results:

Question:	1	2	3	4	5	TOTAL
Achievable:						
Achieved:						

Mark:

[1] Your name is optional

Question 1: Basic Matlab

Q	Max	Achieved
1	14	

(a) In Matlab code `a=rand(20,1)` and `A=rand(20,20)` are a vector a and matrix A of random numbers. What are the dimensions of the results r for the following expressions?

Expression:	diag(a)	A(7:12, 9:20)	A * a
Dimensions:			

(b) Define a vector `x` in Matlab code which represents all even integers for 2 to 2000.

(c) Implement the following function as an anonymous function in Matlab code such that it can be called both for single numbers and vectors:

$$f(x) = (\tan(x) + 1)\ln(x^2 + 5)$$

(d) Define the above function as an inline function.

(e) Write a Matlab script that calculates the mean value of $N \in \mathbb{N}$ random numbers. Do not use loops.

(f) (6 points) Write a Matlab script which plots the curve of descending parachute from $t = 0$ until it reaches z=0. $x(t) = 2\cos(t), \quad y(t) = 2\sin(t), \quad z(t) = 10 - t$

Q	Max	Achieved
2	14	

Question 2: Root finding

Bisection is a standard approach to find a root of a function. Consider the function $f(x) = e^{-x^2} - 1/2$. It has a root around x=0.83.

(a) Under which requirements does the bisection algorithm work?

Does this requirement hold for the current example (Y or N)?

(b) Describe the update mechanism of the bisection algorithm.

(c) Run the algorithm for four iterations by hand and fill in the results in the following tables (precision 2 digits).

Iteration i	x_L	x_R	$f(x_L)$	$f(x_R)$
1	0.0	1.0		
2				
3				
4				

What is the final error?

error:

Question 3: Ordinary differential eqns

Q	Max	Achieved
3	6	

Classify the following differential equations. Enter their order into the following table and tick the relevant box if an equation is linear, explicit or autonomous. If you want to correct a result use the last line of the table.

No	Ordinary differential equation	order	linear	explicit	autonomous
1	$\frac{dy}{dx} = ay$				
2	$\frac{d^2y}{dx^2} + (\frac{dy}{dx} - y)^2 = 0$				
3	$\frac{d^2y}{dx^2} + (\frac{dy}{dx} - x)^2 = 0$				
	for corrections				