EXAMINATION:	MODEL BUILDING WITH EXCEL AND SPSS	SS 2013
EXAMINER:	PROF. DR. B. ERICHSON, NUMBER OF LECTURE:	**20823**

You are allowed to use
- *a non-programmable pocket calculator without communication functions,*
- *3 sheets of paper with personal notes.*

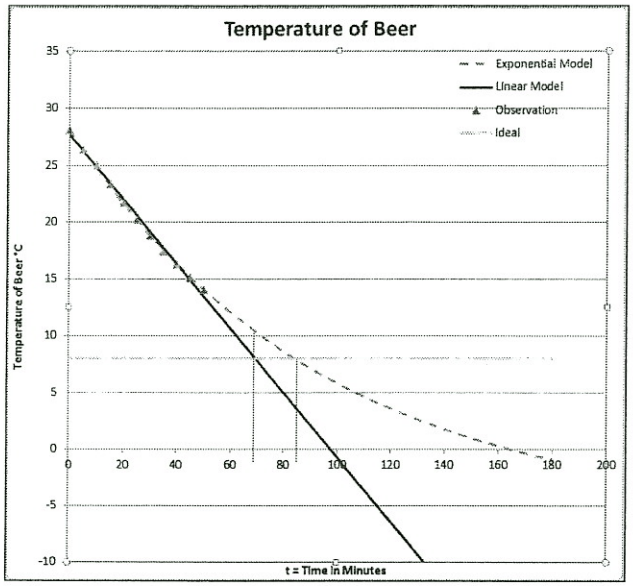
The answers to all questions should be made in one language, please use English or German. Use the space under the question for your answer!
All of the 6 exam questions must be answered (estimated time for each question is given). The examination has 6 pages.
Instead of a decimal "." point in numbers we use a comma "," here!

Question 1: Basics **(10 Min.)**

A Model can be defined as a **simplified representation of a part of reality**. It can serve as a purposeful and convenient **description** of an object or a process. So it must resemble the original with respect to certain **structural** aspects.

a	Name different purposes of models!
b	Models can be classified by form, e.g. physical models, verbal models, graphical models or mathematical models. Of special importance are mathematical models. What advantages do they offer?
c	An important type of models (for business as well as for economics) are Market Response Functions (MRFs). Give two examples of dependent variables in MRFs!
d	Independent variables in MRFs can be divided into controllable and uncontrollable variables. Give two examples of both!
e	How can one characterize the genius of Isaac Newton (1643 – 1727) with respect to model building?

Question 2: Important Models **(10 Min.)**

a	Newton´s formula can be used for predicting beer cooling: $\frac{dT}{dt} = -k \cdot (T - U) \quad \longrightarrow \quad T_t = U + (a - U) \cdot e^{-k \cdot t}$ with $k \approx 0{,}01$ What is the meaning of "U" and "a" in this model? -
b	A still simpler model than the exponential model above is the following linear model: $T_t = a + b \cdot t$ Both models were estimated on observations between 14 and 28 °C (see the graph below).  Compare the two models a) for predictions within the support region! b) for predictions outside the support region!
c	Identical results as with the exponential model can be achieved with the following model: $T_{t+1} - T = -c \cdot [T_t - U] \quad \rightarrow \quad T_t = U + (a - U) \cdot (1 - c)^t$ How is this model called and where is the difference to the exponential model?

Question 3: Methodology and Estimation **(10 Min.)**

The empirical application of mathematical models requires calibration, i.e. fitting to reality by estimation of the model parameters on the basis of empirical data.

a	Which estimation methods (principles) can be used for the calibration (estimation) of models?
b	Nonlinear models are classified into **intrinsically linear models** and **intrinsically non-linear models**. Which of the following models are intrinsically linear? Mark them with a cross below. b1) $Y = \alpha + \beta \cdot \sqrt{X} + u$ b2) $Y = \alpha \cdot X^{\beta} + u$ b3) $Y = \alpha \cdot X^{\beta} \cdot u$ b4) $Y = \alpha + \beta \cdot X^{\gamma} + u$ b5) $Y = 1 - \alpha \cdot e^{-\beta \cdot X + u}$ b6) $Y = M - \alpha \cdot e^{-\beta \cdot X} + u$ O b1 O b2 O b3 O b4 O b5 O b6
c	For estimation it is important to distinguish between linearity in variables (regressors) and linearity in parameters. Which type of **linearity** is required for the application of linear regression analysis?
e	Try to linearize the following exponential function: $Y = 100 - \alpha \cdot e^{-\beta \cdot X} + u$

Question 4: Model Estimation with Excel **(20 Min.)**

Mr. Otto, the marketing-manager of the company Guericke & Co., has performed an advertising experiment to estimate the advertising response function for his product. He has specified an exponential model.

By use of this demand model he wants to support his advertising decisions.

The screenshot below shows the data of the experiment as well as the model that Mr. Otto has developed with MS Excel.

Exponential Model

$$Y = M - a \cdot e^{-b \cdot W} + u$$

Estimation

Daten:

Nr.	Advertising W	Sales Y	$(Y-\bar{Y})^2$
1	22	264,9	2166,6
2	8	176,1	1785,3
3	14	222,7	18,9
4	26	269,3	2595,6
5	12	194,5	569,0
6	2	101,7	13608,0
7	10	174,9	1888,2
8	24	275,3	3242,9
9	6	141,4	5921,8
10	30	286,3	4616,7
11	16	241,0	512,9
12	20	265,9	2260,7
13	18	243,4	627,3
14	4	129,3	7930,5
15	28	288,6	4934,6
	$\bar{Y}=$	218,4	52679,0

Parameter:

		starting values
M =	339,143	0,00
a =	269,551	0,00
b =	0,05777	0,00

$\hat{Y}$	$(Y-\hat{Y})^2$
263,5	1,92
169,3	45,63
219,1	13,09
279,1	96,38
204,4	97,58
99,0	7,27
187,9	168,28
271,8	12,49
148,5	51,11
291,5	27,06
232,2	77,74
254,3	135,70
243,9	0,21
125,2	16,76
285,7	8,60
	759,83
R-square =	
F =	409,98
p =	0,000

Decision

Input:

Avertising Budget	W =	19,7
price	p =	0,5
variable cost	k =	0,3
fixed cost	Cf =	0

Output:

Sales	Y =	252,58
Revenue		126,29
Cost		95,44
Profit	G = R - C =	30,85

a	Which **estimation principle** uses Mr. Otto for the calibration of his model?
b	The estimation fails if all the starting values are set to zero. Show a way to find good starting values!
c	Give the values of c1) The total sum of squares of the sales data! c2) The explained sum of of squares of the sales data!
d	Calculate the value of R-square and specify the formula for cell J25!
e	Specify the formulas for cells P13 (Revenue) and P15 (cost)!
f	What is meant by the "flat maximum principle" for advertising decisions! Which conclusions can you draw from it?

Question 6: Dynamic Advertising Models **(10 Min.)**

The MMM company estimated the following advertising response function:

$$y_t = 2000 + 500 \cdot \ln(w_t) + 0{,}6 \cdot y_{t-1}$$

with y_t = sales in period t

w_t = advertising spending in period t

Aassume: p = 5 price per unit

k = 3 variable cost per unit

a	Which type of model is used here?
b	Give an interpretation of the following formula: $(p-k)\frac{dy(w)}{dw} = 1$
c	What is the optimal advertising budget, if you take a short term perspective?
d	What is the optimal advertising budget, if you take a long term perspective?

Good Luck!