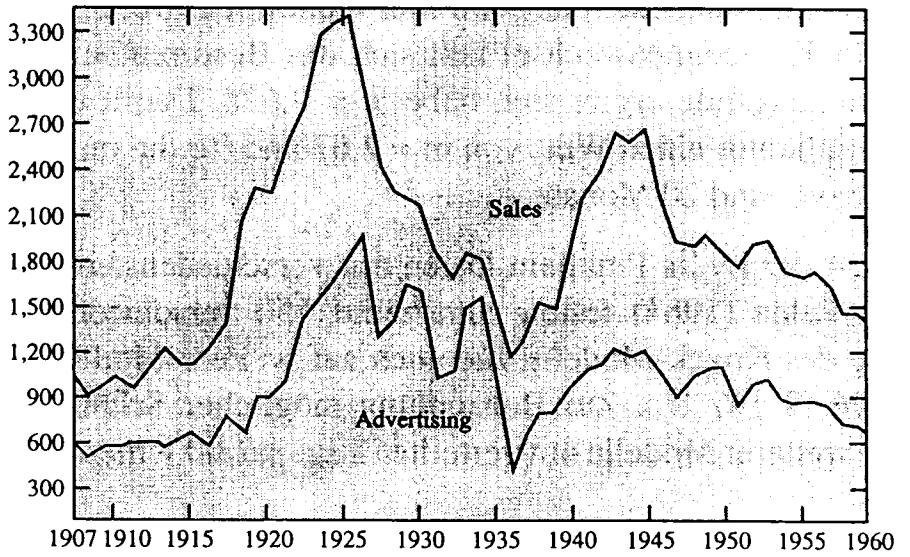
EXAMINATION: MULTIVARIATE ANALYSIS (1201)
(ENGLISH PROGRAM) SS 2001
EXAMINERS: PROF. DR. B. ERICHSON/ DR. J. MARETZKI

You are allowed to use a pocket calculator (in accordance with the instructions given by the examination office) and a translating dictionary from your native language to English (without any notes written in it). The answers to all questions should be made in one language, please use English or German.
All of the 4 exam questions must be answered (the estimated time for each question is given).
This examination has 4 pages.

Question 1 (15 Min.)

The relationship of the domestic sales and advertising of Lydia E. Pinkham Medicine Company 1907-60 (in thousand of dollars) (Source: Palda 1965) is shown by the following diagram.



A SPSS analysis leads to the following Output:

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.930[a]	.865	.859	237.1962

a. Predictors: (Constant), SALESLAG, ADVERTIS

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	18349594	2	???	???	---
	Residual	2869363	51	???		
	Total	21218957	53		(see Question d))	

a. Predictors: (Constant), SALESLAG, ADVERTIS

b. Dependent Variable: SALES

Please turn the page

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	225.827	94.538		2.389	.021
	ADVERTIS	.469	.154	.276	3.043	.004
	SALESLAG	.645	.085	.690	7.618	.000

a. Dependent Variable: SALES

a) Identify the Data Analysis Method.
b) Write down the estimated function (**help**: saleslag means sales in the year before).
c) Explain the idea of the decomposition of dispersion and how it is used in two different goodness of fit measures to prove the quality of the estimation results.
d) Perform a F-Ratio Test (assume the theoretical F-Value: $F_{2,\,51}\,(0.95) = 3.19$).
e) Interpret the estimation results.

Question 2 (15 Min.)

In an empirical market research study competing margarine brands are judged by consumers on relevant attributes. A factor analysis provides the following SPSS Output:

Communalities

	Initial	Extraction
price	1,000	,98290
shelf life	1,000	,95781
calories	1,000	,98967
vitamines	1,000	,99983

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2,64369	66,1	66,1	2,64369	66,1	66,1
2	1,28652	32,2	98,3	1,28652	32,2	98,3
3	4,44E-02	1,1	99,4			
4	2,54E-02	,6	100,0			

Extraction Method: Principal Component Analysis.

Component Matrix[a]

	Component	
	1	2
price	,97196	,19546
shelf life	-,95241	,22520
calories	,58936	-,80145
vitamines	,66675	,74517

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

a) Describe the steps of Factor Analysis.
b) Interpret the SPSS Output. Would you recommend an extraction of further factors? Substantiate your answer.

Please turn the page

Question 3 (15 Min.)

In an empirical market research experiment the influence of shelf height and facings width on sales of canned dog food is measured. The results of 18 observations are shown in the following table (single measures given in parenthesis) (Source: Green/ Tull/ Albaum (1988), p. 477).

	Shelf Height			
Facings	*Knee Level*	*Waist Level*	*Eye Level*	Total
Level 1	(70, 75, 79)	(85, 88, 93)	(77, 81, 78)	
(half width)	224	266	236	726
Level 2	(91, 90, 87)	(94, 97, 93)	(87, 90, 90)	
(full width)	268	284	267	819
Total	492	550	503	1,545

*Cell entries are sales in units.

a) Give reasons for your choice of an appropriate data analysis method.

b) Specify a two-factorial model **without** interaction to answer the question of the company.

c) Formulate the null hypotheses to be tested here and test them by using the SPSS Output given below and the necessary theoretical value (see the tables at the end of the exam).

Tests of Between-Subjects Effects

Dependent Variable: sales

Source	Type III Sum of Squares	df
Corrected Model	796.833[a]	3
Intercept	132612.500	1
SHELF_HEIGHT	316.333	2
FACINGS	480.500	1
Error	161.667	14
Total	133571.000	18
Corrected Total	958.500	17

a. R Squared = .831 (Adjusted R Squared = .795)

d) Specify a two-factorial model **with** interaction and compare the results of these two models by using the given SPSS Outputs (above and below).

Tests of Between-Subjects Effects

Dependent Variable: sales

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	853.167[a]	5	170.633	19.439	.000
Intercept	132612.500	1	132612.500	15107.753	.000
SHELF_HEIGHT	316.333	2	158.167	18.019	.000
FACINGS	480.500	1	480.500	54.741	.000
SHELF_HEIGHT * FACINGS	56.333	2	28.167	3.209	.077
Error	105.333	12	8.778		
Total	133571.000	18			
Corrected Total	958.500	17			

a. R Squared = .890 (Adjusted R Squared = .844)

Please turn the page

Question 4 (15 Min.)

You are Marketing Manager of a brewing company. To improve the communication program of your brewery you made a survey concerning the preferences for different products. You got the following results of $n_{..} = 200$ respondents: in the group of the male respondents 19 prefer light beer, 63 prefer lager, and 58 prefer strong beer; the female respondents have answered: 31 prefer light, 17 lager and 12 strong beer.

a) Is there a relationship between sex and beer preferences? Perform a Contingency analysis ($\alpha = 0.05$) and interpret the results (see additional information below).

b) Calculate the Phi-Coefficient (φ), the Contingency Coefficient (CC), and Cramer's V and give a short interpretation of each result (see additional information below).

Additional information:

Formulas: $\chi^2 = \sum_{i=1}^{I}\sum_{j=1}^{J}\frac{\left(n_{ij} - e_{ij}\right)^2}{e_{ij}}$ Phi-Coefficient (φ): $\varphi = \sqrt{\frac{\chi^2}{n_{..}}}$

Contingency Coefficient (CC): $CC = \sqrt{\frac{\chi^2}{\chi^2 + n_{..}}}$ [with upper bound:

$CC_{max} = \sqrt{(R-1)/R}$ and $R = \min(I, J)$]

Cramer's V: $V = \sqrt{\frac{\chi^2}{n_{..}(R-1)}}$

χ^2-Table (german decimal notation)

FG \ α	0,10	0,05	0,025	0,01	0,001
1	2,71	3,84	5,02	6,63	10,83
2	4,61	5,99	7,38	9,21	13,82
3	6,25	7,81	9,35	11,34	16,27
4	7,78	9,49	11,14	13,28	18,47
5	9,24	11,07	12,83	15,09	20,52
6	10,64	12,59	14,45	16,81	22,46
7	12,02	14,07	16,01	18,48	24,32
8	13,36	15,51	17,53	20,09	26,13
9	14,68	16,92	19,02	21,67	27,88
10	15,99	18,31	20,48	23,21	29,59
11	17,28	19,68	21,92	24,73	31,26
12	18,55	21,03	23,34	26,22	32,91
13	19,81	22,36	24,74	27,69	34,53
14	21,06	23,68	26,12	29,14	36,12
15	22,31	25,00	27,49	30,58	37,70
16	23,54	26,30	28,85	32,00	39,25
17	24,77	27,59	30,19	33,41	40,79
18	25,99	28,87	31,53	34,81	42,31
19	27,20	30,14	32,85	36,19	43,82
20	28,41	31,41	34,17	37,57	45,31
22	30,81	33,92	36,78	40,29	48,27
24	33,20	36,42	39,36	42,98	51,18
26	35,56	38,89	41,92	45,64	54,05
28	37,92	41,34	44,46	48,28	56,89
30	40,26	43,77	46,98	50,89	59,70
35	46,06	49,80	53,20	57,34	66,62
40	51,81	55,76	59,34	63,69	73,40
50	63,17	67,50	71,42	76,15	86,66
60	74,40	79,08	83,30	88,38	99,61
80	96,58	101,88	106,63	112,33	124,84
100	118,50	124,34	129,56	135,81	149,45
120	140,23	146,57	152,21	158,95	173,62
150	172,58	179,58	185,80	193,21	209,26
200	226,02	233,99	241,06	249,45	267,54
	1,282	1,645	1,96	2,326	3,090

Percentiles of the F Distribution ($\alpha = 0.05$)

ν_2 \ ν_1	1	2	3	4	5	6	7
1	161,4	199,5	215,7	224,6	230,2	234,0	236,8
2	18,51	19,00	19,16	19,25	19,30	19,33	19,35
3	10,13	9,55	9,28	9,12	9,01	8,94	8,89
4	7,71	6,94	6,59	6,39	6,26	6,16	6,09
5	6,61	5,79	5,41	5,19	5,05	4,95	4,88
6	5,99	5,14	4,76	4,53	4,39	4,28	4,21
7	5,59	4,74	4,35	4,12	3,97	3,87	3,79
8	5,32	4,46	4,07	3,84	3,69	3,58	3,50
9	5,12	4,26	3,86	3,63	3,48	3,37	3,29
10	4,96	4,10	3,71	3,48	3,33	3,22	3,14
11	4,84	3,98	3,59	3,36	3,20	3,09	3,01
12	4,75	3,89	3,49	3,26	3,11	3,00	2,91
13	4,67	3,81	3,41	3,18	3,03	2,92	2,83
14	4,60	3,74	3,34	3,11	2,96	2,85	2,76
15	4,54	3,68	3,29	3,06	2,90	2,79	2,71
16	4,49	3,63	3,24	3,01	2,85	2,74	2,66
17	4,45	3,59	3,20	2,96	2,81	2,70	2,61
18	4,41	3,55	3,16	2,93	2,77	2,66	2,58
19	4,38	3,52	3,13	2,90	2,74	1,63	2,54
20	4,35	3,49	3,10	2,87	2,71	2,60	2,51
21	4,32	3,47	3,07	2,84	2,68	2,57	2,49
22	4,30	3,44	3,05	2,82	2,66	2,55	2,46
23	4,28	3,42	3,03	2,80	2,64	2,53	2,44
24	4,26	3,40	3,01	2,78	2,62	2,51	2,42

ν_1 degrees of freedom for numerator

ν_2 degrees of freedom for denominator

(german decimal notation)

Good Luck!