FINAL EXAM

STA 110 - Summer 1994
Brani Vidakovic
SATURDAY 8/6/1994.

Name ____

Notes:

1. This is an open book and open notes exam.
2. You must show your work and explain your answer in order to receive credit.
3. The exam carries 100 points.
4. The points assigned to each problem are indicated at the front page. Use them to plan your time. You have maximum 3 hours to finish.
5. The exam has 6 problems. Make sure your copy has all of them!

Space Craft	**Feminism**	**Families**	**Insects**	**New Mexico**	**Nematodes**	Total
/15	/15	/15	/20	/15	/20	/100

Launching a space craft. The trust produced by standard rocket fuel and used to lift a space craft safely off the launch pad is a random variable with the mean $\mu_0 = 4$ million lbs., and with the standard deviation $\sigma = 0.2$ millions lbs. A company has come with a modification of rocket fuel that is cheaper than the standard fuel. They claim their experiments have shown the new fuel is as good as the currently used fuel. However, the engineers are concerned that the new fuel gives less trust than the safe 4 millions lbs.

(a) State the research hypothesis engineers are interested in. HINT: THAT IS H_1 HYPOTHESIS

(b) State the error of first kind and the error of second kind in terms of the problem. Which error is more serious here?

(c) If $n = 8$ machines are tested and the average thrust was 3.875 millions lbs. what is your decision at $\alpha = 0.05$? Use one-sided alternative.

Feminism and Authoritarianism. A study[1] compared peoples attitudes toward feminism with their degree of authoritarianism. Two samples were used, one consisting of 30 subjects who were rated high in authoritarianism, and a second sample of 31 subjects who were rated low. Each subject was given an 18-item test designed to reveal attitudes on feminism, with scores reported on a scale from 18 to 90 (High scores indicated pro-feminism). Summary statistics from the study are as follows:

Authoritarianism	n	$\bar{X}$	s
High	30	67.7	11.8
Low	31	52.4	13.0

Assume that variances in the 'High' and 'Low' subpopulations are the same.

(a) State H_0. What type of test is appropriate and why?

(b) Perform the test against the two sided alternative. Use $\alpha = 0.05$.

(c) Which one-sided alternative will be appropriate in this problem. You may find this piece of Splus output useful:

```
n1= 30  n2= 31  pooled s= 12.425
```

[1]Sarup, G. (1976). Gender, authoritarianism, and attitude towards feminism. *Soc.Behav.Personality* 4 *57-64.*

Family sizes and income. A demographer surveys 1000 randomly chosen American families and records their family sizes and family incomes:

	Family Size					
Family Income	2	3	4	5	6	7
Low	145	81	57	22	9	8
Middle	151	73	71	33	13	10
High	124	60	80	42	13	8

Do the data provide sufficient evidence to conclude that family size and family income are statistically dependent? The following Splus printout may help:

```
> tab_matrix(c(145,81,57,22,9,8,151,73,71,33,13,10,124,60,80,42,13,8),3,6,
+  byrow=T)
>  dimnames(tab)_list(c("Low Inc","Midd Inc","High Inc"),
+  c("Fam size 2", "Fam size 3", "Fam size 4", "Fam size 5", "Fam size 6",
+ "Fam size 7"))

> tab
         Fam size 2 Fam size 3 Fam size 4 Fam size 5 Fam size 6 Fam size 7
 Low Inc        145         81         57         22          9          8
Midd Inc        151         73         71         33         13         10
High Inc        124         60         80         42         13          8

> Cont.tab(tab)

------------------------------------------------------------

Dimensions are  3 * 6 .         Degrees of freedom=_________
Chi-square= 16.28          p-value= erased by the instructor.

------------------------------------------------------------
```

(a) State H_0 and H_1 hypotheses.

(b) Perform the test. Use $\alpha = 0.05$;   Comment.

(c) Would you change the decision in (b) if α were 0.10.

Insecticides. In recent years environmentalists and health professionals have been concerned about the ill effects on the environment of the widespread use of insecticides. Insecticides kill insects-and much else as well. They often find their way into the systems of animals, and even people. In order for human beings to cope with the problem and make decisions how to deal with it, they must understand the effect of insecticides on humans and other animals. In the kind of study often done to promote such understanding, Mount and Oehme [2] investigated the effect of a commonly used insecticide on sheep. They derived the following linear regression equation for relationship between the activity of a certain enzyme in sheep's brain (Y) and the time (in hours) after the sheep has been exposed to the insecticide (X):

$$Y = 26.879 + 1.39X$$

Fill in the ANOVA Table:

```
-------------------------------------------------------------------
Source      SS          df          MS          F           p
-------------------------------------------------------------------
Regr                              657.985                   0
Error     15.681
Total                   15
-------------------------------------------------------------------
s=                              R-squared=
-------------------------------------------------------------------
Regression line is:  y = 26.879 + 1.391 * x
-------------------------------------------------------------------
Parameter         Estim       St.dev         t         p-value
Intercept                                 48.431          0
Slope                                     24.237          0
-------------------------------------------------------------------
```

(a) Is the regression justifiable?

(b) Test the hypothesis that the slope $\beta = 1.5$, against the two sided alternative. Take $\alpha = 0.05$.

[2] Mount, M. and Oehme, F. (1981). Diagnostic criteria for Carbaryl Poisoning in sheep, *Archives of Environmental Contamination and Toxicology,* **10** *483-495.*

(c) Find 95% confidence interval for the intercept α.

(d) What is y for $x = 7.5$ hours.

(e) Make a few general comments on the model proposed (predictability, F, R-squared, ...)

New Mexico wells. The accompanying data are calcium carbonate ($CaCO_3$) readings (parts per million cubic centimeters) for ten wells in the Atrisco well field (one of the water sources for Albequerque, New Mexico) for 1961 and 1966.

	YEAR	
Well No.	1961	1966
1	185	256
2	92	58
3	112	190
4	82	98
5	108	142
6	117	142
7	62	138
8	64	166
9	92	64
10	76	130

There was a concern that the $CaCO_3$ levels in the water supply were rising during that period. Is this concern substantiated by the data? Test at 10% significance level. You will find the following Splus calculations useful.

```
> y1961_c(185, 92, 112, 82, 108, 117,62, 64, 92, 76)
> y1966_c(256, 58, 190, 98, 142,142, 138, 166, 64, 130)
> diff_y1961-y1966
> diff
 [1]  -71   34  -78  -16  -34  -25  -76 -102   28  -54
> mean(diff)
[1] -39.4
> var(diff)
[1] 2074.933
> sqrt(var(diff))
[1] 45.55144
```

Nematodes. Some varieties of nematodes (roundworms that live in the soil and are frequently so small they are invisible to the naked eye) feed on the roots of lawn grasses and crops such as strawberries and tomatoes. This pest, which is particularly troublesome in warm climates, can be treated by the application of nematocides. However, because of size of the worms, it is very difficult to measure the effectiveness of these pesticides directly. To compare four nematocides, the yields of equal-size plots of one variety of tomatoes were collected. The data (yields in pounds per plot) are shown in the table.

Nematocide A	Nematocide B	Nematocide C	Nematocide D
18.6	18.7	19.4	19.0
18.4	19.0	18.9	18.8
18.4	18.9	19.5	18.6
18.5	18.5	19.1	18.7
17.9		18.5	

One-way ANOVA was run and SPLUS output is given below.

```
> a1_c(18.6, 18.4, 18.4, 18.5, 17.9)
> a2_c(18.7, 19.0, 18.9, 18.5, NA)
> a3_c(19.4, 18.9, 19.5, 19.1 ,18.5 )
> a4_c(19.0, 18.8 ,18.6, 18.7, NA)
> an_cbind(a1,a2,a3,a4)
> an
       a1   a2   a3   a4
[1,] 18.6 18.7 19.4 19.0
[2,] 18.4 19.0 18.9 18.8
[3,] 18.4 18.9 19.5 18.6
[4,] 18.5 18.5 19.1 18.7
[5,] 17.9   NA 18.5   NA
> Anova(an)
```

Fill in the table:

```
---------------------------------------------------------
Source  SS      df      MS      F       p
---------------------------------------------------------
Treat  1.309                            0.0127
Error
Total
---------------------------------------------------------
RootMSE= 0.29    R-squared=
---------------------------------------------------------
```

(a) Explain what kind of statistical problems are solved by ANOVA. State H_0 and H_1 hypotheses.

(b) What is your decision if $\alpha = 0.05$? State the decision in terms of the problem.