Biology 4605/7220 Name_____
EXAM #2 10 November 1992

In ANALYSIS I (attached) Ivlev (1961, Experimental Ecology of the Feeding of Fishes) reported the time to starvation D50 of Bleak Alburnus alburnus in relation to age (A = days) and body length (BL = mm). D50 is the number of days to 50% mortality.

In ANALYSIS II (attached) Steel and Torrie (Principles and Procedures of Statistics 1960) report oat yield (Yield = bushels/acre) from for treated and untreated seeds infected by *H. victoriae*.

In ANALYSIS III (attached) Steel and Torrie (1960) report oat yields for treated and untreated seeds that were not infected by *H. victoriae.*

1. For ANALYSIS I.
a. Write a pair of hypotheses (H_o/H_A) about D50 of Bleak as a function of age A.

b. State a criterion of significance α = _____

c. Declare a decision about D50 in relation to age
(and report p-value with statement of decision).

Starvation depends on metabolic rate, which scales as body volume$^{2/3}$ or as body length^2.
A plot for Bleak is shown in ANALYSIS I.

d. Write a pair of hypotheses (H_0/H_A) about D50 of Bleak as a function of size
(BLsq = mm^2).

e. Using the criterion you stated above, declare a decision about D50 in
relation to BLsq (and report p-value with statement of decision).

2f. Size and age are highly correlated in Ivlev's experiment (see ANALYSIS I). Design and explain an experiment to decide whether starvation in bleak depends on age, or size, or both.

2. For ANALYSIS II.

a. Complete the missing line (3 blanks) in the ANOVA table.

b. The treatment effects are significant at $\alpha = 1\%$ in one test ($p=0.001$) but not in the other ($p = 0.026$). Explain why the decision for one test differs from that of the other in ANALYSIS II.

c. Which of the two tests would you use ? (Explain why).

3. For ANALYSIS III.

a. Write a complete General Linear Model of Yield in terms of Infection (inf) and chemical treatment (tr).

b. Calculate an F-statistic for each of the 3 explanatory terms in the model (fill in 3 blanks in ANALYSIS III).

c. Declare a decision (at $\alpha = 0.05$) for each explanatory term (report p-values).

d. The manufacturer of Ceresan chemical treatment challenges your conclusion in ANALYSIS III on the grounds that the assumptions for ANOVA were not met. How would you answer this challenge to your analysis ?

e. The manufacturer of Ceresan chemical treatment challenges your conclusion in ANALYSIS III on the grounds that Type II error was high. How would you handle this challenge to your analysis ?

ANALYSIS I (Bleak)

Data from Ivlev (1961 Table 77). age in days, D50 in days, BL = mm

```
MTB > print c1-c4

  ROW     age    BL   BLsq    D50

    1     0.1     4     16      3
    2    10.0     8     64     11
    3    25.0    14    196     21
    4    50.0    22    484     51
    5    75.0    27    729     68
    6   100.0    33   1089    109

MTB > plot 'D50' 'age'
          -                                                    *
       105+
          -
D50       -
          -
          -
        70+                                        *
          -
          -
          -                          *
          -
        35+
          -
          -               *
          -      *
          -
         0+ *
          +---------+---------+---------+---------+---------+------age
          0         20        40        60        80       100

MTB > regress 'D50' 1 'age'

The regression equation is
D50 = - 0.72 + 1.03 age

Predictor       Coef       Stdev    t-ratio        p
Constant      -0.716       3.933      -0.18    0.864
age          1.02767     0.07018      14.64    0.000

s = 6.108       R-sq = 98.2%     R-sq(adj) = 97.7%

Analysis of Variance

SOURCE       DF          SS          MS         F        p
Regression    1      7999.6      7999.6    214.45    0.000
Error         4       149.2        37.3
Total         5      8148.8
```

ANALYSIS I (Bleak, continued)

```
MTB > plot 'D50' 'BLsq'

        -                                                              *
     105+
        -
D50     -
        -
        -
       70+                                      *
        -
        -
        -                          *
        -
       35+
        -
        -            *
        -    *
        -
        0+  *
         +---------+---------+---------+---------+---------+------BLsq
           0       200       400       600       800      1000

MTB > regress 'D50' 1 'BLsq'

The regression equation is
D50 = 2.73 + 0.0957 BLsq

Predictor       Coef       Stdev    t-ratio        p
Constant       2.731       1.802       1.52    0.204
BLsq        0.095660    0.003126      30.60    0.000

s = 2.943       R-sq = 99.6%     R-sq(adj) = 99.5%

Analysis of Variance

SOURCE       DF          SS          MS         F        p
Regression    1      8114.2      8114.2    936.55    0.000
Error         4        34.7         8.7
Total         5      8148.8


MTB > !Analysis of BLEAK
```

ANALYSIS II (Ceresan)

Data from Steel and Torrie 1960 p237. Yield of oats (Vicland, infected with H. victoriae) in bushels/acre
Chemical seed treatment (Ceresan) compared to control in 4 blocks.

```
MTB > print c1 c2

 ROW  control  ceresan

   1     42.9     53.8
   2     41.6     58.5
   3     28.9     43.9
   4     30.8     46.3

MTB > anova 'yield' = 'tr'

Factor     Type Levels Values
tr        fixed      2     0     1

Analysis of Variance for yield

Source      DF         SS         MS       F      P
tr           1      424.9     424.86    8.72  0.026
Error        6      292.4      48.74
Total        7      717.3     102.47

MTB > anova 'yield' = 'tr' 'block';
SUBC> random 'block'.

Factor     Type Levels Values
tr        fixed      2     0     1
block    random      4     1     2     3     4

Analysis of Variance for yield

Source      DF         SS         MS       F      P
tr           1    424.861    424.861  127.79  0.001
block     ____    _______    _______   28.32  0.011  <---BLANKS HERE
Error        3      9.974      3.325
Total        7    717.299    102.471

MTB > print c3-c5

 ROW  yield   tr  block

   1   42.9    0      1
   2   41.6    0      2
   3   28.9    0      3
   4   30.8    0      4
   5   53.8    1      1
   6   58.5    1      2
   7   43.9    1      3
   8   46.3    1      4
```

ANALYSIS III (Ceresan)

Data from Steel and Torrie 1960. p237.
Yield of oats, in bushels/acre. inf = infected or not
tr = Ceresan chemical seed treatment or not

```
 MTB > name  c7 'tr'
 MTB > print c5-c7
```

ROW	yield	inf	tr
1	42.9	0	0
2	41.6	0	0
3	28.9	0	0
4	30.8	0	0
5	53.8	0	1
6	58.5	0	1
7	43.9	0	1
8	46.3	0	1
9	53.3	1	0
10	69.6	1	0
11	45.4	1	0
12	35.1	1	0
13	57.6	1	1
14	69.6	1	1
15	42.4	1	1
16	51.9	1	1

```
 MTB > anova 'yield' = 'inf' 'tr' 'inf'*'tr'

 Factor     Type Levels Values
 inf       fixed      2     0     1
 tr        fixed      2     0     1

 Analysis of Variance for yield
```

Source	DF	SS	MS	F	P
inf	1	382.2	382.2	------	0.086
tr	1	364.8	364.8	------	0.093
inf*tr	1	101.0	101.0	------	0.356
Error	12	1315.5	109.6		
Total	15	2163.5	144.2		

```
MTB > hist 'res'

 Histogram of res   N = 16

 Midpoint   Count
      -15       2  **
      -10       0
       -5       6  ******
        0       2  **
        5       3  ***
       10       1  *
       15       1  *
       20       1  *
```