

```

2 *****;
3 *** Example of unbalanced CRD with experimental error ***;
4 *** From Snedecor & Cochran, 1967 (pg 278) ***;
5 *****;
6 OPTIONS PS=256 LS=132 NOCENTER NODATE PAGENO=1 NONUMBER;
7 dm 'log;clear;output;clear';
8 DATA MICE onebyone; INFILE CARDS MISSOEVER;
9 INPUT STRAIN $ 1-4 DAYS NUMBER;
10 TITLE1 'EXST7015: DAYS TO DEATH FOR MICE INOCULATED WITH 3 TYPHOID
STRAINS';
11 TITLE2 'UNEQUAL NUMBER OF MICE IN EACH TREATMENT';
12 do i = 1 to number by 1; output onebyone; end;
13 output mice;
14 CARDS;

```

NOTE: The data set WORK.MICE has 31 observations and 4 variables.

NOTE: The data set WORK.ONEBYONE has 224 observations and 4 variables.

NOTE: DATA statement used:

```

real time          0.08 seconds
cpu time           0.08 seconds

```

```

14 !          RUN;
46 ;
47 PROC MIXED DATA=OnebyOne cl covtest; CLASSES STRAIN;
48 TITLE3 'ANALYSIS OF VARIANCE with PROC MIXED';
49 MODEL DAYS = STRAIN / htype=3 DDFM=Satterthwaite;
50 repeated / group=strain;
51 LSMEANS STRAIN / ADJUST=TUKEY pdiff;
52 LSMEANS STRAIN / ADJUST=SCHEFFE pdiff;
53 LSMEANS STRAIN / ADJUST=BON pdiff;
54 *NOTE that normally only one post-ANOVA examination would be
55 done. We have done several here for comparison. ;
56 RUN;

```

NOTE: Convergence criteria met.

NOTE: The PROCEDURE MIXED printed page 1.

NOTE: PROCEDURE MIXED used:

```

real time          0.11 seconds
cpu time           0.11 seconds

```

```

EXST7015: DAYS TO DEATH FOR MICE INOCULATED WITH 3 TYPHOID STRAINS
UNEQUAL NUMBER OF MICE IN EACH TREATMENT
ANALYSIS OF VARIANCE with PROC MIXED

```

The Mixed Procedure

Model Information	
Data Set	WORK.ONEBYONE
Dependent Variable	DAYS
Covariance Structure	Variance Components
Group Effect	STRAIN
Estimation Method	REML
Residual Variance Method	None
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Satterthwaite

Class Level Information		
Class	Levels	Values
STRAIN	3	11C 9D DSC1

Dimensions

Covariance Parameters	3
Columns in X	4
Columns in Z	0
Subjects	224
Max Obs Per Subject	1
Observations Used	224
Observations Not Used	0
Total Observations	224

Iteration History

Iteration	Evaluations	-2 Res Log Like	Criterion
0	1	1027.49256195	
1	1	1012.92789611	0.00000000

Convergence criteria met.

Covariance Parameter Estimates

Cov Parm	Group	Estimate	Standard Error	Z Value	Pr > Z	Alpha	Lower	Upper
Residual	STRAIN 11C	5.8633	1.0795	5.43	<.0001	0.05	4.2127	8.7221
Residual	STRAIN 9D	1.8989	0.4903	3.87	<.0001	0.05	1.2126	3.3928
Residual	STRAIN DSC1	6.6327	0.8164	8.12	<.0001	0.05	5.2839	8.5761

Fit Statistics

-2 Res Log Likelihood	1012.9
AIC (smaller is better)	1018.9
AICC (smaller is better)	1019.0
BIC (smaller is better)	1029.2

Null Model Likelihood Ratio Test

DF	Chi-Square	Pr > ChiSq
2	14.56	0.0007

Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
STRAIN	2	114	70.10	<.0001

Least Squares Means

Effect	STRAIN	Estimate	Standard Error	DF	t Value	Pr > t
STRAIN	11C	7.3667	0.3126	59	23.57	<.0001
STRAIN	9D	4.0323	0.2475	30	16.29	<.0001
STRAIN	DSC1	7.7970	0.2233	132	34.91	<.0001
STRAIN	11C	7.3667	0.3126	59	23.57	<.0001
STRAIN	9D	4.0323	0.2475	30	16.29	<.0001
STRAIN	DSC1	7.7970	0.2233	132	34.91	<.0001
STRAIN	11C	7.3667	0.3126	59	23.57	<.0001
STRAIN	9D	4.0323	0.2475	30	16.29	<.0001
STRAIN	DSC1	7.7970	0.2233	132	34.91	<.0001

Differences of Least Squares Means

Effect	STRAIN	_STRAIN	Estimate	Standard Error	DF	t Value	Pr > t	Adjustment	Adj P
STRAIN	11C	9D	3.3344	0.3987	88.1	8.36	<.0001	Tukey-Kramer	<.0001
STRAIN	11C	DSC1	-0.4303	0.3842	121	-1.12	0.2649	Tukey-Kramer	0.5037
STRAIN	9D	DSC1	-3.7647	0.3334	85.8	-11.29	<.0001	Tukey-Kramer	<.0001
STRAIN	11C	9D	3.3344	0.3987	88.1	8.36	<.0001	Scheffe	<.0001
STRAIN	11C	DSC1	-0.4303	0.3842	121	-1.12	0.2649	Scheffe	0.5358
STRAIN	9D	DSC1	-3.7647	0.3334	85.8	-11.29	<.0001	Scheffe	<.0001
STRAIN	11C	9D	3.3344	0.3987	88.1	8.36	<.0001	Bonferroni	<.0001
STRAIN	11C	DSC1	-0.4303	0.3842	121	-1.12	0.2649	Bonferroni	0.7950
STRAIN	9D	DSC1	-3.7647	0.3334	85.8	-11.29	<.0001	Bonferroni	<.0001

```
57      PROC GLM DATA=MICE; CLASSES STRAIN; FREQ NUMBER;
58      TITLE3 'ANALYSIS OF VARIANCE with PROC GLM';
59      MODEL DAYS = STRAIN;
60      MEANS STRAIN / LSD TUKEY SCHEFFE BON;
61      run;
```

NOTE: PROCEDURE GLM used:

```
real time      0.09 seconds
cpu time       0.09 seconds
```

EXST7015: DAYS TO DEATH FOR MICE INOCULATED WITH 3 TYPHOID STRAINS
UNEQUAL NUMBER OF MICE IN EACH TREATMENT
ANALYSIS OF VARIANCE with PROC GLM

The GLM Procedure

```
Class Level Information
Class      Levels  Values
STRAIN      3      11C 9D DSC1
Number of observations      224
```

Dependent Variable: DAYS
Frequency: NUMBER

Source	DF	Sum of Squares	Mean Square	F Value
Pr > F				
Model	2	359.794413	179.897207	31.10
<.0001				
Error	221	1278.419872	5.784705	
Corrected Total	223	1638.214286		

R-Square	Coeff Var	Root MSE	DAYS Mean
0.219626	33.58801	2.405141	7.160714

Source	DF	Type I SS	Mean Square	F Value
Pr > F				
STRAIN	2	359.7944135	179.8972067	31.10
<.0001				

Source	DF	Type III SS	Mean Square	F Value
Pr > F				
STRAIN	2	359.7944135	179.8972067	31.10
<.0001				

t Tests (LSD) for DAYS

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

```
Alpha      0.05
Error Degrees of Freedom      221
Error Mean Square      5.784705
Critical Value of t      1.97076
```

Comparisons significant at the 0.05 level are indicated by ***.

STRAIN Comparison	Difference	95% Confidence		
	Between Means	Limits		
DSC1 - 11C	0.4303	-0.3068	1.1675	
DSC1 - 9D	3.7647	2.8194	4.7101	***
11C - DSC1	-0.4303	-1.1675	0.3068	
11C - 9D	3.3344	2.2860	4.3828	***
9D - DSC1	-3.7647	-4.7101	-2.8194	***
9D - 11C	-3.3344	-4.3828	-2.2860	***

EXST7015: DAYS TO DEATH FOR MICE INOCULATED WITH 3 TYPHOID STRAINS
UNEQUAL NUMBER OF MICE IN EACH TREATMENT
ANALYSIS OF VARIANCE with PROC GLM

The GLM Procedure

Tukey's Studentized Range (HSD) Test for DAYS

NOTE: This test controls the Type I experimentwise error rate.

Alpha 0.05
Error Degrees of Freedom 221
Error Mean Square 5.784705
Critical Value of Studentized Range 3.33708

Comparisons significant at the 0.05 level are indicated by ***.

STRAIN Comparison	Difference		Simultaneous 95%		
	Between Means		Confidence Limits		
DSC1 - 11C	0.4303		-0.4523	1.3129	
DSC1 - 9D	3.7647		2.6328	4.8966	***
11C - DSC1	-0.4303		-1.3129	0.4523	
11C - 9D	3.3344		2.0791	4.5897	***
9D - DSC1	-3.7647		-4.8966	-2.6328	***
9D - 11C	-3.3344		-4.5897	-2.0791	***

Bonferroni (Dunn) t Tests for DAYS

NOTE: This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than Tukey's for all pairwise comparisons.

Alpha 0.05
Error Degrees of Freedom 221
Error Mean Square 5.784705
Critical Value of t 2.41234

Comparisons significant at the 0.05 level are indicated by ***.

STRAIN Comparison	Difference		Simultaneous 95%		
	Between Means		Confidence Limits		
DSC1 - 11C	0.4303		-0.4720	1.3326	
DSC1 - 9D	3.7647		2.6076	4.9219	***
11C - DSC1	-0.4303		-1.3326	0.4720	
11C - 9D	3.3344		2.0511	4.6178	***
9D - DSC1	-3.7647		-4.9219	-2.6076	***
9D - 11C	-3.3344		-4.6178	-2.0511	***

Scheffe's Test for DAYS

NOTE: This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than Tukey's for all pairwise comparisons.

Alpha 0.05
Error Degrees of Freedom 221
Error Mean Square 5.784705
Critical Value of F 3.03671

Comparisons significant at the 0.05 level are indicated by ***.

STRAIN Comparison	Difference		Simultaneous 95%		
	Between Means		Confidence Limits		
DSC1 - 11C	0.4303		-0.4915	1.3521	
DSC1 - 9D	3.7647		2.5826	4.9469	***
11C - DSC1	-0.4303		-1.3521	0.4915	
11C - 9D	3.3344		2.0234	4.6455	***
9D - DSC1	-3.7647		-4.9469	-2.5826	***
9D - 11C	-3.3344		-4.6455	-2.0234	***