```
ods rtf file='hw6_s23.rtf';

title 'Problem 1';
data sun;
infile 'sunflower.csv' firstobs=2 dsd;
input field yield;
run;

proc print data=sun;
run;

proc mixed data=sun cl covtest method=type1;
class field;
model yield = ;
random field;
run;


title 'Problem 2: Analysis of Two-Factor Mixed Effects Model (PROC MIXED)';
data sun2;
infile 'variety.csv' firstobs=2 dsd;
input variety field yield;
run;

proc print data=sun2;
run;

title 'Problem 2: Analysis of Two-Factor Mixed Effects Model (PROC MIXED with ANOVA
Method)';
proc mixed data=sun2 cl covtest method=type1;
class variety field;
model yield = variety;
random field variety*field;
run;

title 'Analysis of Two-Factor Mixed Effects Model (PROC MIXED with REML Method)';
proc mixed data=sun2 cl covtest method=reml;
class variety field;
model yield = variety;
random field variety*field;
run;


ods rtf close;
```

Problem 1

Obs	field	yield
1	1	69.32
2	1	68.58
3	1	71.89
4	1	71.34
5	2	65.86
6	2	68.20
7	2	72.14
8	2	70.09
9	3	73.87
10	3	74.26
11	3	72.80
12	3	68.29
13	4	70.32
14	4	69.93
15	4	69.10
16	4	72.25
17	5	72.63
18	5	73.79
19	5	70.29
20	5	69.99
21	6	70.69
22	6	70.12
23	6	70.40
24	6	70.02
25	7	72.04
26	7	73.57
27	7	73.05
28	7	73.76
29	8	72.69
30	8	72.73
31	8	67.12
32	8	71.75
33	9	70.54
34	9	69.57
35	9	70.96

Problem 1

Obs	field	yield
36	9	71.96
37	10	73.09
38	10	71.18
39	10	69.00
40	10	70.59

Problem 1

The Mixed Procedure

Model Information	
Data Set	WORK.SUN
Dependent Variable	yield
Covariance Structure	Variance Components
Estimation Method	Type 1
Residual Variance Method	Factor
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Containment

Class Level Information		
Class	**Levels**	**Values**
field	10	1 2 3 4 5 6 7 8 9 10

Dimensions	
Covariance Parameters	2
Columns in X	1
Columns in Z	10
Subjects	1
Max Obs per Subject	40

Number of Observations	
Number of Observations Read	40
Number of Observations Used	40
Number of Observations Not Used	0

Type 1 Analysis of Variance								
Source	**DF**	**Sum of Squares**	**Mean Square**	**Expected Mean Square**	**Error Term**	**Error DF**	**F Value**	**Pr > F**
field	9	46.897003	5.210778	Var(Residual) + 4 Var(field)	MS(Residual)	30	1.53	0.1828
Residual	30	102.180775	3.406026	Var(Residual)	.	.	.	.

Problem 1

The Mixed Procedure

Covariance Parameter Estimates							
Cov Parm	**Estimate**	**Standard Error**	**Z Value**	**Pr Z**	**Alpha**	**Lower**	**Upper**
field	0.4512	0.6523	0.69	0.4891	0.05	-0.8272	1.7296
Residual	3.4060	0.8794	3.87	<.0001	0.05	2.1750	6.0855

Fit Statistics	
-2 Res Log Likelihood	166.0
AIC (Smaller is Better)	170.0
AICC (Smaller is Better)	170.3
BIC (Smaller is Better)	170.6

Problem 2: Analysis of Two-Factor Mixed Effects Model (PROC MIXED)

Obs	variety	field	yield
1	1	1	71.70
2	1	1	73.18
3	1	2	72.80
4	1	2	70.33
5	1	3	72.67
6	1	3	74.82
7	1	4	70.27
8	1	4	70.83
9	1	5	72.15
10	1	5	71.45
11	1	6	69.18
12	1	6	70.86
13	1	7	71.42
14	1	7	73.06
15	1	8	70.72
16	1	8	71.14
17	2	1	70.31
18	2	1	69.93
19	2	2	72.31
20	2	2	73.85
21	2	3	71.86
22	2	3	71.63
23	2	4	68.07
24	2	4	72.46
25	2	5	70.61
26	2	5	69.61
27	2	6	69.35
28	2	6	71.18
29	2	7	72.13
30	2	7	70.79
31	2	8	71.73
32	2	8	70.56
33	3	1	69.77
34	3	1	71.54
35	3	2	70.44

Problem 2: Analysis of Two-Factor Mixed Effects Model (PROC MIXED)

Obs	variety	field	yield
36	3	2	71.50
37	3	3	66.81
38	3	3	66.80
39	3	4	67.79
40	3	4	68.87
41	3	5	67.67
42	3	5	68.93
43	3	6	68.14
44	3	6	65.57
45	3	7	70.73
46	3	7	72.07
47	3	8	65.77
48	3	8	70.52

Problem 2: Analysis of Two-Factor Mixed Effects Model (PROC MIXED with ANOVA Method)

The Mixed Procedure

Model Information	
Data Set	WORK.SUN2
Dependent Variable	yield
Covariance Structure	Variance Components
Estimation Method	Type 1
Residual Variance Method	Factor
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Containment

Class Level Information		
Class	**Levels**	**Values**
variety	3	1 2 3
field	8	1 2 3 4 5 6 7 8

Dimensions	
Covariance Parameters	3
Columns in X	4
Columns in Z	32
Subjects	1
Max Obs per Subject	48

Number of Observations	
Number of Observations Read	48
Number of Observations Used	48
Number of Observations Not Used	0

Type 1 Analysis of Variance								
Source	**DF**	**Sum of Squares**	**Mean Square**	**Expected Mean Square**	**Error Term**	**Error DF**	**F Value**	**Pr > F**
variety	2	65.204317	32.602158	Var(Residual) + 2 Var(variety*field) + Q(variety)	MS(variety*field)	14	11.10	0.0013
field	7	40.809433	5.829919	Var(Residual) + 2 Var(variety*field) + 6 Var(field)	MS(variety*field)	14	1.98	0.1302
variety*field	14	41.118917	2.937065	Var(Residual) + 2 Var(variety*field)	MS(Residual)	24	1.63	0.1431
Residual	24	43.366900	1.806954	Var(Residual)	.	.	.	.

Problem 2: Analysis of Two-Factor Mixed Effects Model (PROC MIXED with ANOVA Method)

The Mixed Procedure

Covariance Parameter Estimates							
Cov Parm	**Estimate**	**Standard Error**	**Z Value**	**Pr Z**	**Alpha**	**Lower**	**Upper**
field	0.4821	0.5513	0.87	0.3819	0.05	-0.5985	1.5628
variety*field	0.5651	0.6133	0.92	0.3569	0.05	-0.6369	1.7671
Residual	1.8070	0.5216	3.46	0.0003	0.05	1.1017	3.4970

Fit Statistics	
-2 Res Log Likelihood	177.6
AIC (Smaller is Better)	183.6
AICC (Smaller is Better)	184.2
BIC (Smaller is Better)	183.9

Type 3 Tests of Fixed Effects				
Effect	**Num DF**	**Den DF**	**F Value**	**Pr > F**
variety	2	14	11.10	0.0013

Analysis of Two-Factor Mixed Effects Model (PROC MIXED with REML Method)

The Mixed Procedure

Model Information	
Data Set	WORK.SUN2
Dependent Variable	yield
Covariance Structure	Variance Components
Estimation Method	REML
Residual Variance Method	Profile
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Containment

Class Level Information		
Class	**Levels**	**Values**
variety	3	1 2 3
field	8	1 2 3 4 5 6 7 8

Dimensions	
Covariance Parameters	3
Columns in X	4
Columns in Z	32
Subjects	1
Max Obs per Subject	48

Number of Observations	
Number of Observations Read	48
Number of Observations Used	48
Number of Observations Not Used	0

Iteration History			
Iteration	**Evaluations**	**-2 Res Log Like**	**Criterion**
0	1	182.10270496	
1	1	177.64643272	0.00000000

Convergence criteria met.

Analysis of Two-Factor Mixed Effects Model (PROC MIXED with REML Method)

The Mixed Procedure

Covariance Parameter Estimates							
Cov Parm	**Estimate**	**Standard Error**	**Z Value**	**Pr > Z**	**Alpha**	**Lower**	**Upper**
field	0.4821	0.5513	0.87	0.1909	0.05	0.1162	50.7742
variety*field	0.5651	0.6133	0.92	0.1784	0.05	0.1427	39.2677
Residual	1.8070	0.5216	3.46	0.0003	0.05	1.1017	3.4970

Fit Statistics	
-2 Res Log Likelihood	177.6
AIC (Smaller is Better)	183.6
AICC (Smaller is Better)	184.2
BIC (Smaller is Better)	183.9

Type 3 Tests of Fixed Effects				
Effect	**Num DF**	**Den DF**	**F Value**	**Pr > F**
variety	2	14	11.10	0.0013