

```

1      TITLE1 'Example of Randomized Complete Block Design (RBD)';
2      dm'log;clear;output;clear';
3
4      ODS HTML style=minimal body='C:\EXST 7005\SAS\Example07.html' ;
NOTE: Writing HTML Body file: C:\EXST 7005\SAS\Example07.html
5      ODS RTF style=minimal body='C:\EXST 7005\SAS\Example07.rtf';
NOTE: Writing RTF Body file: C:\EXST 7005\SAS\Example07.rtf
6      ODS PDF style=minimal body='C:\EXST 7005\SAS\Example07.PDF'=:;
NOTE: Writing ODS PDF output to DISK destination
      "C:\EXST 7005\SAS\Example07.PDF", printer "PDF".
7
8      *****;
9      *** Neter, Kutner, Nachtsheim, Wasserman (1996) [Ch24pr17.sas] ***;
10     *** Artificial pearl quality depends on the number of coats ***;
11     *** of lacquer applied. The experiment evaluates the market ***;
12     *** value of the pearls and The number of coats applied. The ***;
13     *** experiment was reproduced on 4 different batches of pearls ***;
14     *****;
15     options ps=256 ls=99 nocenter nodate nonumber nolabel;
16
17     data pearls; infile cards missover;
18         TITLE2 'Artificial pearl market value with coats of lacquer';
19         LABEL value = 'Market value of the pearl';
20         LABEL coats = 'coats of lacquer';
21         LABEL batch = 'Batch of pearls produced';
22         LABEL rep = 'A pearl within a batch';
23         input value c batch rep;
24         coats = (c-2)*2+8;
25         cards;
NOTE: The data set WORK.PEARLS has 48 observations and 5 variables.
NOTE: DATA statement used (Total process time):
      real time          0.01 seconds
      cpu time           0.01 seconds

25     !           run;
74     ;
75     PROC PRINT DATA=pearls; TITLE3 'LISTING OF DATA'; RUN;
NOTE: There were 48 observations read from the data set WORK.PEARLS.
NOTE: The PROCEDURE PRINT printed page 1.
NOTE: PROCEDURE PRINT used (Total process time):
      real time          0.12 seconds
      cpu time           0.03 seconds
    
```

Example of Randomized Complete Block Design (RBD)  
 Artificial pearl market value with coats of lacquer  
 LISTING OF DATA

Obs	value	coats	batch	rep	c	17	76.9	8	1	1	2
1	72.0	6	1	1	1	18	78.1	8	1	2	2
2	74.6	6	1	2	1	19	72.9	8	1	3	2
3	67.4	6	1	3	1	20	74.2	8	1	4	2
4	72.8	6	1	4	1	21	80.3	8	2	1	2
5	72.1	6	2	1	1	22	79.3	8	2	2	2
6	76.9	6	2	2	1	23	76.6	8	2	3	2
7	74.8	6	2	3	1	24	77.2	8	2	4	2
8	73.3	6	2	4	1	25	80.2	8	3	1	2
9	75.2	6	3	1	1	26	76.6	8	3	2	2
10	73.8	6	3	2	1	27	77.3	8	3	3	2
11	75.7	6	3	3	1	28	79.9	8	3	4	2
12	77.8	6	3	4	1	29	74.3	8	4	1	2
						30	77.6	8	4	2	2
13	70.4	6	4	1	1	31	74.4	8	4	3	2
14	68.1	6	4	2	1	32	72.9	8	4	4	2
15	72.4	6	4	3	1	33	76.3	10	1	1	3
16	72.4	6	4	4	1	34	74.1	10	1	2	3

35	77.1	10	1	3	3	42	78.0	10	3	2	3
36	75.0	10	1	4	3	43	77.6	10	3	3	3
37	80.9	10	2	1	3	44	81.2	10	3	4	3
38	73.7	10	2	2	3	45	71.6	10	4	1	3
39	78.6	10	2	3	3	46	77.7	10	4	2	3
40	80.2	10	2	4	3	47	75.2	10	4	3	3
41	79.2	10	3	1	3	48	74.4	10	4	4	3

```

76
77 PROC MIXED DATA=PEARLS ORDER=DATA; CLASSES BATCH COATS;
78 TITLE3 'Randomized block design with PROC MIXED';
79 MODEL VALUE = COATS;
80 RANDOM BATCH BATCH*COATS;
81 lsmeans coats / adjust=tukey pdiff;
82 ** treatments in order=data ====> 6 8 10;
83 contrast 'linear trend' coats -1 0 1;
84 contrast 'curved trend' coats -1 2 -1;
85 ods output diffs=ppp lsmeans=mmm;
86 *ods listing exclude diffs lsmeans; *this line is inactive;
87 RUN;

```

NOTE: Convergence criteria met.  
 NOTE: Estimated G matrix is not positive definite.  
 NOTE: The data set WORK.MMM has 3 observations and 7 variables.  
 NOTE: The data set WORK.PPP has 3 observations and 10 variables.  
 NOTE: The PROCEDURE MIXED printed page 2.  
 NOTE: PROCEDURE MIXED used (Total process time):  
 real time 0.12 seconds  
 cpu time 0.04 seconds

Example of Randomized Complete Block Design (RBD)  
 Artificial pearl market value with coats of lacquer  
 Randomized block design with PROC MIXED

The Mixed Procedure

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

Class Level Information  
 Class Levels Values  
 batch 4 1 2 3 4  
 coats 3 6 8 10

Dimensions  
 Covariance Parameters 3  
 Columns in X 4  
 Columns in Z 16  
 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	225.45311480	
1	2	207.86808217	0.00000079
2	1	207.86803230	0.00000000

Convergence criteria met.

Covariance Parameter

Estimates

Cov Parm	Estimate
batch	3.8974
batch*coats	0
Residual	4.1780

Fit Statistics

-2 Res Log Likelihood	207.9
AIC (smaller is better)	211.9
AICC (smaller is better)	212.2
BIC (smaller is better)	210.6

Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
coats	2	6	18.00	0.0029

Contrasts

Label	Num DF	Den DF	F Value	Pr > F
linear trend	1	6	27.92	0.0019
curved trend	1	6	8.07	0.0295

Least Squares Means

Effect	coats	Estimate	Standard Error	DF	t Value	Pr >  t
coats	6	73.1062	1.1115	6	65.77	<.0001
coats	8	76.7937	1.1115	6	69.09	<.0001
coats	10	76.9250	1.1115	6	69.21	<.0001

Differences of Least Squares Means

Effect	coats	_coats	Estimate	Standard Error	DF	t Value	Pr >  t	Adjustment	Adj P
coats	6	8	-3.6875	0.7227	6	-5.10	0.0022	Tukey-Kramer	0.0053
coats	6	10	-3.8187	0.7227	6	-5.28	0.0019	Tukey-Kramer	0.0045
coats	8	10	-0.1312	0.7227	6	-0.18	0.8619	Tukey-Kramer	0.9820

Example of Randomized Complete Block Design (RBD)

Artificial pearl market value with coats of lacquer

Randomized block design with PROC MIXED

Post hoc adjustment with macro by Arnold Saxton

Effect=coats ADJUSTMENT=Tukey-Kramer(P<0.05) BYGROUP=1

Obs	coats	Estimate	StdErr	MSGROUP
1	10	76.9250	1.1115	A
2	8	76.7937	1.1115	A
3	6	73.1062	1.1115	B

```

89      TITLE4 'Post hoc adjustment with macro by Arnold Saxton';
90      * SAS Macro by Arnold Saxton: Saxton, A.M. 1998. A macro for          ;
91      * converting mean separation output to letter groupings in Proc Mixed. ;
92      * In Proc. 23rd SAS Users Group Intl., SAS Institute, Cary, NC, ppl243-1246.;
93      %include 'C:\Geaghan\EXST\EXST7005New\Fall2003\Sas\pdmix800.sas';
721     %pdmix800(ppp,mmm,alpha=0.05,sort=yes);
PDMIX800 03.26.2002 processing
4.3390183727
Tukey-Kramer values for coats are 2.21727 (avg) 2.21727 (min) 2.21727 (max).
722     run;
723
724     PROC GLM DATA=PEARLS ORDER=DATA; CLASSES BATCH COATS;
725     TITLE3 'Randomized block design with PROC GLM';
726     MODEL VALUE = BATCH COATS BATCH*COATS;
727     RANDOM BATCH BATCH*COATS / TEST;
728     TEST H=BATCH COATS E=BATCH*COATS;
729     lsmeans coats / adjust=tukey pdiff stderr;
730     contrast 'linear trend' coats -1 0 1;
731     contrast 'curved trend' coats -1 2 -1;
732     RUN;
NOTE: TYPE I EMS not available without the E1 option.
733
734     ods html close;
735     ods rtf close;
736     ods PDF close;
NOTE: ODS PDF printed 11 pages to C:\EXST 7005\SAS\Example07.PDF.
737
738     run;
739     quit;
NOTE: The PROCEDURE GLM printed pages 4-9.
NOTE: PROCEDURE GLM used (Total process time):
      real time          0.53 seconds
      cpu time           0.09 seconds

```

Example of Randomized Complete Block Design (RBD)  
 Artificial pearl market value with coats of lacquer  
 Randomized block design with PROC GLM

#### The GLM Procedure

##### Class Level Information

Class	Levels	Values
batch	4	1 2 3 4
coats	3	6 8 10

Number of Observations Read	48
Number of Observations Used	48

Example of Randomized Complete Block Design (RBD)  
 Artificial pearl market value with coats of lacquer  
 Randomized block design with PROC GLM

The GLM Procedure

Dependent Variable: value

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	305.0916667	27.7356061	5.75	<.0001
Error	36	173.6250000	4.8229167		
Corrected Total	47	478.7166667			

R-Square	Coeff Var	Root MSE	value Mean
0.637312	2.904593	2.196114	75.60833

Source	DF	Type I SS	Mean Square	F Value	Pr > F
batch	3	152.8516667	50.9505556	10.56	<.0001
coats	2	150.3879167	75.1939583	15.59	<.0001
batch*coats	6	1.8520833	0.3086806	0.06	0.9988

Source	DF	Type III SS	Mean Square	F Value	Pr > F
batch	3	152.8516667	50.9505556	10.56	<.0001
coats	2	150.3879167	75.1939583	15.59	<.0001
batch*coats	6	1.8520833	0.3086806	0.06	0.9988

Example of Randomized Complete Block Design (RBD)  
 Artificial pearl market value with coats of lacquer  
 Randomized block design with PROC GLM

The GLM Procedure

Source	Type III Expected Mean Square
batch	Var(Error) + 4 Var(batch*coats) + 12 Var(batch)
coats	Var(Error) + 4 Var(batch*coats) + Q(coats)
batch*coats	Var(Error) + 4 Var(batch*coats)

Example of Randomized Complete Block Design (RBD)  
 Artificial pearl market value with coats of lacquer  
 Randomized block design with PROC GLM

The GLM Procedure

Tests of Hypotheses for Mixed Model Analysis of Variance

Dependent Variable: value

Source	DF	Type III SS	Mean Square	F Value	Pr > F
batch	3	152.851667	50.950556	165.06	<.0001
coats	2	150.387917	75.193958	243.60	<.0001
Error	6	1.852083	0.308681		
Error: MS(batch*coats)					

Source	DF	Type III SS	Mean Square	F Value	Pr > F
batch*coats	6	1.852083	0.308681	0.06	0.9988
Error: MS(Error)	36	173.625000	4.822917		

Example of Randomized Complete Block Design (RBD)  
 Artificial pearl market value with coats of lacquer  
 Randomized block design with PROC GLM

Least Squares Means

Adjustment for Multiple Comparisons: Tukey

coats	value LSMEAN	Standard Error	Pr >  t	LSMEAN Number
6	73.1062500	0.5490285	<.0001	1
8	76.7937500	0.5490285	<.0001	2
10	76.9250000	0.5490285	<.0001	3

Least Squares Means for effect coats  
 Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: value

i/j	1	2	3
1		<.0001	<.0001
2	<.0001		0.9844
3	<.0001	0.9844	

Dependent Variable: value

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
linear trend	1	116.6628125	116.6628125	24.19	<.0001
curved trend	1	33.7251042	33.7251042	6.99	0.0120

Tests of Hypotheses Using the Type III MS for batch\*coats as an Error Term

Source	DF	Type III SS	Mean Square	F Value	Pr > F
batch	3	152.8516667	50.9505556	165.06	<.0001
coats	2	150.3879167	75.1939583	243.60	<.0001