```
/* x6_5.sas */
/* Purpose:  */

title1 'Example 6.5.';

data a;
input plant$ dry1-dry6 /
      plant$ nit1-nit6 /
      plant$ gre1-gre6;
  block=1; dry=dry1; nit=nit1; gre=gre1; output;
  block=2; dry=dry2; nit=nit2; gre=gre2; output;
  block=3; dry=dry3; nit=nit3; gre=gre3; output;
  block=4; dry=dry4; nit=nit4; gre=gre4; output;
  block=5; dry=dry5; nit=nit5; gre=gre5; output;
  block=6; dry=dry6; nit=nit6; gre=gre6; output;
keep plant block dry nit gre;
cards;
marchigi   9.170  10.683  10.063   8.104  10.018   9.570
marchigi   0.286   0.335   0.315   0.259   0.319   0.304
marchigi  40.959  47.677  44.950  36.919  45.859  43.838
kayseri    9.403  10.914  11.018  11.385  13.387  12.848
kayseri    0.285   0.330   0.333   0.339   0.400   0.383
kayseri   42.475  49.546  50.152  51.718  60.758  58.334
atlantic  11.349  10.971   9.794   8.944  11.715  11.903
atlantic   0.369   0.357   0.319   0.291   0.379   0.386
atlantic  52.475  50.757  45.151  42.221  55.505  56.364
;

proc print data=a;
title2 'List of data';

proc anova data=a;
  class plant block;
  model dry nit gre = plant block;
  manova h=plant /printh printe summary;
  manova h=block /printh printe summary;
title2 'Multivariate ANOVA.';

run;
```

Example 6.5. 1
List of data

Obs	plant	block	dry	nit	gre
1	marchigi	1	9.170	0.286	40.959
2	marchigi	2	10.683	0.335	47.677
3	marchigi	3	10.063	0.315	44.950
4	marchigi	4	8.104	0.259	36.919
5	marchigi	5	10.018	0.319	45.859
6	marchigi	6	9.570	0.304	43.838
7	kayseri	1	9.403	0.285	42.475
8	kayseri	2	10.914	0.330	49.546
9	kayseri	3	11.018	0.333	50.152
10	kayseri	4	11.385	0.339	51.718
11	kayseri	5	13.387	0.400	60.758
12	kayseri	6	12.848	0.383	58.334
13	atlantic	1	11.349	0.369	52.475
14	atlantic	2	10.971	0.357	50.757
15	atlantic	3	9.794	0.319	45.151
16	atlantic	4	8.944	0.291	42.221
17	atlantic	5	11.715	0.379	55.505
18	atlantic	6	11.903	0.386	56.364

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Example 6.5. 2
Multivariate ANOVA.

The ANOVA Procedure

Class Level Information

Class	Levels	Values
plant	3	atlantic kayseri marchigi
block	6	1 2 3 4 5 6

Number of Observations Read	18
Number of Observations Used	18

Example 6.5. 3
Multivariate ANOVA.

The ANOVA Procedure

Dependent Variable: dry

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	22.16385172	3.16626453	3.18	0.0482
Error	10	9.97011456	0.99701146		
Corrected Total	17	32.13396628			

R-Square	Coeff Var	Root MSE	dry Mean
0.689733	9.398231	0.998505	10.62439

Source	DF	Anova SS	Mean Square	F Value	Pr > F
plant	2	10.94560411	5.47280206	5.49	0.0246
block	5	11.21824761	2.24364952	2.25	0.1288

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Example 6.5. 4
Multivariate ANOVA.

The ANOVA Procedure

Dependent Variable: nit

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	0.01883306	0.00269044	3.24	0.0456
Error	10	0.00831056	0.00083106		
Corrected Total	17	0.02714361			

R-Square	Coeff Var	Root MSE	nit Mean
0.693830	8.664295	0.028828	0.332722

Source	DF	Anova SS	Mean Square	F Value	Pr > F
plant	2	0.00803078	0.00401539	4.83	0.0340
block	5	0.01080228	0.00216046	2.60	0.0932

Example 6.5. 5
Multivariate ANOVA.

The ANOVA Procedure

Dependent Variable: gre

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	521.8764857	74.5537837	3.91	0.0258
Error	10	190.6005383	19.0600538		
Corrected Total	17	712.4770240			

R-Square	Coeff Var	Root MSE	gre Mean
0.732482	8.974289	4.365782	48.64767

Source	DF	Anova SS	Mean Square	F Value	Pr > F
plant	2	260.1739723	130.0869862	6.83	0.0135
block	5	261.7025133	52.3405027	2.75	0.0817

```
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```

Example 6.5. 6
Multivariate ANOVA.

The ANOVA Procedure
Multivariate Analysis of Variance

E = Error SSCP Matrix

	dry	nit	gre
dry	9.9701145556	0.2866667222	43.4540855
nit	0.2866667222	0.0083105556	1.2551111667
gre	43.4540855	1.2551111667	190.60053833

Partial Correlation Coefficients from the Error SSCP Matrix / Prob > |r|

DF = 10	dry	nit	gre
dry	1.000000	0.995892 <.0001	0.996824 <.0001
nit	0.995892 <.0001	1.000000	0.997252 <.0001
gre	0.996824 <.0001	0.997252 <.0001	1.000000

Example 6.5. 7
Multivariate ANOVA.

The ANOVA Procedure
Multivariate Analysis of Variance

H = Anova SSCP Matrix for plant

	dry	nit	gre
dry	10.945604111	0.2626132778	52.369429167
nit	0.2626132778	0.0080307778	1.3854275
gre	52.369429167	1.3854275	260.17397233

Characteristic Roots and Vectors of: E Inverse * H, where
H = Anova SSCP Matrix for plant
E = Error SSCP Matrix

Characteristic Root	Percent	Characteristic Vector V'EV=1 dry	nit	gre
32.4644928	80.26	-2.435105	147.599412	-0.422089
7.9847662	19.74	-3.194655	-39.956718	1.019420
0.0000000	0.00	1.147449	28.545542	-0.382971

MANOVA Test Criteria and F Approximations for
the Hypothesis of No Overall plant Effect
H = Anova SSCP Matrix for plant
E = Error SSCP Matrix

S=2 M=0 N=3

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.00332590	43.57	6	16	<.0001
Pillai's Trace	1.85881808	39.50	6	18	<.0001
Hotelling-Lawley Trace	40.44925895	51.86	6	9.0909	<.0001
Roy's Greatest Root	32.46449279	97.39	3	9	<.0001

NOTE: F Statistic for Roy's Greatest Root is an upper bound.
NOTE: F Statistic for Wilks' Lambda is exact.

```
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```

Example 6.5. 8
Multivariate ANOVA.

The ANOVA Procedure
Multivariate Analysis of Variance

Dependent Variable: dry

Source	DF	Anova SS	Mean Square	F Value	Pr > F
plant	2	10.94560411	5.47280206	5.49	0.0246
Error	10	9.97011456	0.99701146		

```
                        Example 6.5.                              9
                     Multivariate ANOVA.

                     The ANOVA Procedure
                Multivariate Analysis of Variance

Dependent Variable: nit

 Source                DF       Anova SS    Mean Square   F Value   Pr > F

 plant                  2     0.00803078     0.00401539      4.83   0.0340
 Error                 10     0.00831056     0.00083106

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                        Example 6.5.                             10
                     Multivariate ANOVA.

                     The ANOVA Procedure
                Multivariate Analysis of Variance

Dependent Variable: gre

 Source                DF       Anova SS    Mean Square   F Value   Pr > F

 plant                  2    260.1739723    130.0869862      6.83   0.0135
 Error                 10    190.6005383     19.0600538

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                        Example 6.5.                             11
                     Multivariate ANOVA.

                     The ANOVA Procedure
                Multivariate Analysis of Variance

                    E = Error SSCP Matrix

                    dry               nit                gre

        dry      9.9701145556      0.2866667222       43.4540855
        nit      0.2866667222      0.0083105556     1.2551111667
        gre        43.4540855      1.2551111667     190.60053833


    Partial Correlation Coefficients from the Error SSCP Matrix / Prob > |r|

              DF = 10           dry            nit            gre

              dry          1.000000       0.995892       0.996824
                                            <.0001         <.0001

              nit          0.995892       1.000000       0.997252
                             <.0001                        <.0001

              gre          0.996824       0.997252       1.000000
                             <.0001         <.0001
```



```
                        Example 6.5.                             12
                     Multivariate ANOVA.

                     The ANOVA Procedure
                Multivariate Analysis of Variance

                 H = Anova SSCP Matrix for block

                          dry                nit                gre

          dry    11.218247611       0.3480119444       53.974648667
          nit    0.3480119444       0.0108022778       1.6712966667
          gre    53.974648667       1.6712966667       261.70251333


          Characteristic Roots and Vectors of: E Inverse * H, where
                 H = Anova SSCP Matrix for block
                      E = Error SSCP Matrix

      Characteristic              Characteristic Vector  V'EV=1
                Root     Percent             dry             nit              gre

          5.01196572       75.50       -2.645653      -70.288702         1.092998
          1.61793607       24.37       -1.455556      117.236093        -0.393400
          0.00831011        0.13       -2.886880       74.243994         0.120970


              MANOVA Test Criteria and F Approximations for
                the Hypothesis of No Overall block Effect
                 H = Anova SSCP Matrix for block
                      E = Error SSCP Matrix

                          S=3    M=0.5    N=3

Statistic                        Value    F Value    Num DF    Den DF    Pr > F

Wilks' Lambda               0.06301303       2.58        15    22.486    0.0205
Pillai's Trace              1.45992638       1.90        15        30    0.0663
Hotelling-Lawley Trace      6.63821190       3.27        15    10.704    0.0283
Roy's Greatest Root         5.01196572      10.02         5        10    0.0012

        NOTE: F Statistic for Roy's Greatest Root is an upper bound.

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                        Example 6.5.                             13
                     Multivariate ANOVA.

                     The ANOVA Procedure
                Multivariate Analysis of Variance

Dependent Variable: dry

 Source                DF       Anova SS    Mean Square   F Value   Pr > F

 block                  5    11.21824761     2.24364952      2.25   0.1288
 Error                 10     9.97011456     0.99701146
```

Example 6.5. 14
Multivariate ANOVA.

The ANOVA Procedure
Multivariate Analysis of Variance

Dependent Variable: nit

Source	DF	Anova SS	Mean Square	F Value	Pr > F
block	5	0.01080228	0.00216046	2.60	0.0932
Error	10	0.00831056	0.00083106		

```
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```

Example 6.5. 15
Multivariate ANOVA.

The ANOVA Procedure
Multivariate Analysis of Variance

Dependent Variable: gre

Source	DF	Anova SS	Mean Square	F Value	Pr > F
block	5	261.7025133	52.3405027	2.75	0.0817
Error	10	190.6005383	19.0600538		