```
/* x3_4.sas */
/* Purpose:  */

title1 'Example 3.4.';

data a;
  input y a b;
  cards;
13.4 1 0
12.3 1 0
 9.3 0 1
 8.7 0 1
;

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

proc glm data=a;
  model y=a b /noint solution xpx inverse e;
title2 'Analysis by GLM.';

proc glm data=a;
  model y=a b /solution xpx inverse e;
title2 'Alternative analysis by GLM.';

proc means data=a;
var y;
by b a;
title2 'Respective means.';

run;
```

```
                              Example 3.4.                                     1
                             List of data.

                          Obs      y     a    b

                           1     13.4    1    0
                           2     12.3    1    0
                           3      9.3    0    1
                           4      8.7    0    1

/><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<
                              Example 3.4.                                     2
                            Analysis by GLM.

                           The GLM Procedure

                   Number of Observations Read           4
                   Number of Observations Used           4

/><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<
                              Example 3.4.                                     3
                            Analysis by GLM.

                           The GLM Procedure

                            The X'X Matrix

                                 a                 b                 y

      a                          2                 0              25.7
      b                          0                 2                18
      y                       25.7                18            493.03

/><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<
                              Example 3.4.                                     4
                            Analysis by GLM.

                           The GLM Procedure

                          X'X Inverse Matrix

                                 a                 b                 y

      a                        0.5                 0             12.85
      b                          0               0.5                 9
      y                      12.85                 9             0.785

/><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<
                              Example 3.4.                                     5
                            Analysis by GLM.

                           The GLM Procedure

                  General Form of Estimable Functions

                      Effect        Coefficients

                      a             L1

                      b             L2
```



```
                              Example 3.4.                                     6
                            Analysis by GLM.

                           The GLM Procedure

Dependent Variable: y

                                        Sum of
 Source                      DF        Squares    Mean Square    F Value    Pr > F

 Model                        2    492.2450000    246.1225000     627.06    0.0016

 Error                        2      0.7850000      0.3925000

 Uncorrected Total            4    493.0300000


               R-Square     Coeff Var      Root MSE        y Mean

               0.998408      5.734537      0.626498      10.92500

NOTE: No intercept term is used: R-square is not corrected for the mean.


 Source                      DF      Type I SS    Mean Square    F Value    Pr > F

 a                            1    330.2450000    330.2450000     841.39    0.0012
 b                            1    162.0000000    162.0000000     412.74    0.0024


 Source                      DF    Type III SS    Mean Square    F Value    Pr > F

 a                            1    330.2450000    330.2450000     841.39    0.0012
 b                            1    162.0000000    162.0000000     412.74    0.0024


                                                Standard
       Parameter         Estimate              Error    t Value    Pr > |t|

       a              12.85000000         0.44300113      29.01      0.0012
       b               9.00000000         0.44300113      20.32      0.0024

/><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<
                              Example 3.4.                                     7
                      Alternative analysis by GLM.

                           The GLM Procedure

                   Number of Observations Read           4
                   Number of Observations Used           4

/><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<
                              Example 3.4.                                     8
                      Alternative analysis by GLM.

                           The GLM Procedure

                            The X'X Matrix

                      Intercept                a                b                y

 Intercept                    4                2                2             43.7
```

a	2	2	0	25.7
b	2	0	2	18
y	43.7	25.7	18	493.03


```
                            Example 3.4.                                    9
                     Alternative analysis by GLM.

                          The GLM Procedure

                    X'X Generalized Inverse (g2)

                  Intercept               a               b               y

Intercept               0.5            -0.5               0               9
a                      -0.5               1               0            3.85
b                         0               0               0               0
y                         9            3.85               0           0.785

/><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<>><<
                            Example 3.4.                                   10
                     Alternative analysis by GLM.

                          The GLM Procedure

                  General Form of Estimable Functions

                      Effect        Coefficients

                      Intercept     L1

                      a             L2

                      b             L1-L2
```

```
                               Example 3.4.                               11
                       Alternative analysis by GLM.

                            The GLM Procedure

Dependent Variable: y

                                           Sum of
 Source                          DF       Squares    Mean Square   F Value   Pr > F

 Model                            1   14.82250000    14.82250000     37.76   0.0255

 Error                            2    0.78500000     0.39250000

 Corrected Total                  3   15.60750000


              R-Square     Coeff Var      Root MSE        y Mean

              0.949704      5.734537      0.626498      10.92500


 Source                          DF     Type I SS    Mean Square   F Value   Pr > F

 a                                1   14.82250000    14.82250000     37.76   0.0255
 b                                0    0.00000000         .            .        .


 Source                          DF   Type III SS    Mean Square   F Value   Pr > F

 a                                0             0              .       .        .
 b                                0             0              .       .        .


                                                 Standard
      Parameter         Estimate                    Error    t Value    Pr > |t|

      Intercept      9.000000000 B      0.44300113      20.32      0.0024
      a              3.850000000 B      0.62649820       6.15      0.0255
      b              0.000000000 B       .                .          .

NOTE: The X'X matrix has been found to be singular, and a generalized inverse
      was used to solve the normal equations.  Terms whose estimates are
      followed by the letter 'B' are not uniquely estimable.
```



```
                               Example 3.4.                               12
                             Respective means.

---------------------------------- b=0 a=1 -----------------------------------

                            The MEANS Procedure

                          Analysis Variable : y

       N            Mean         Std Dev         Minimum         Maximum
       -----------------------------------------------------------------
       2      12.8500000       0.7778175      12.3000000      13.4000000
       -----------------------------------------------------------------


---------------------------------- b=1 a=0 -----------------------------------

                          Analysis Variable : y

       N            Mean         Std Dev         Minimum         Maximum
       -----------------------------------------------------------------
       2       9.0000000       0.4242641       8.7000000       9.3000000
       -----------------------------------------------------------------
```