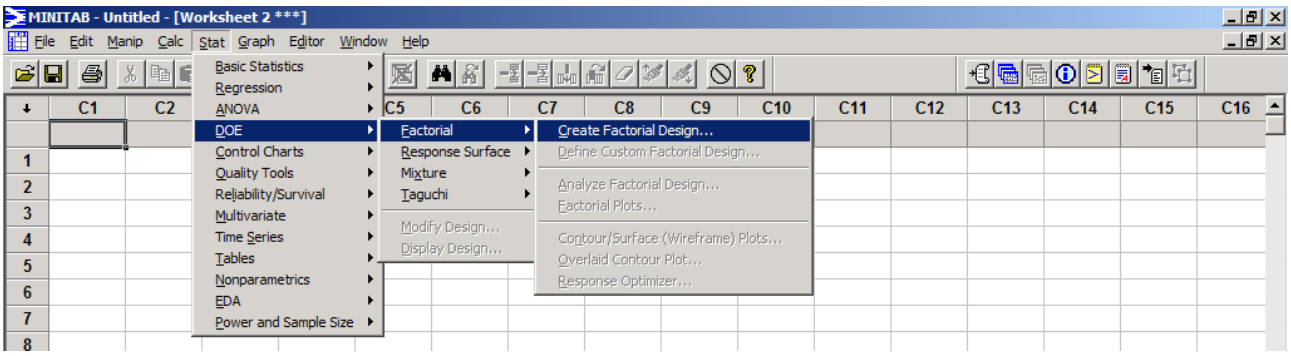
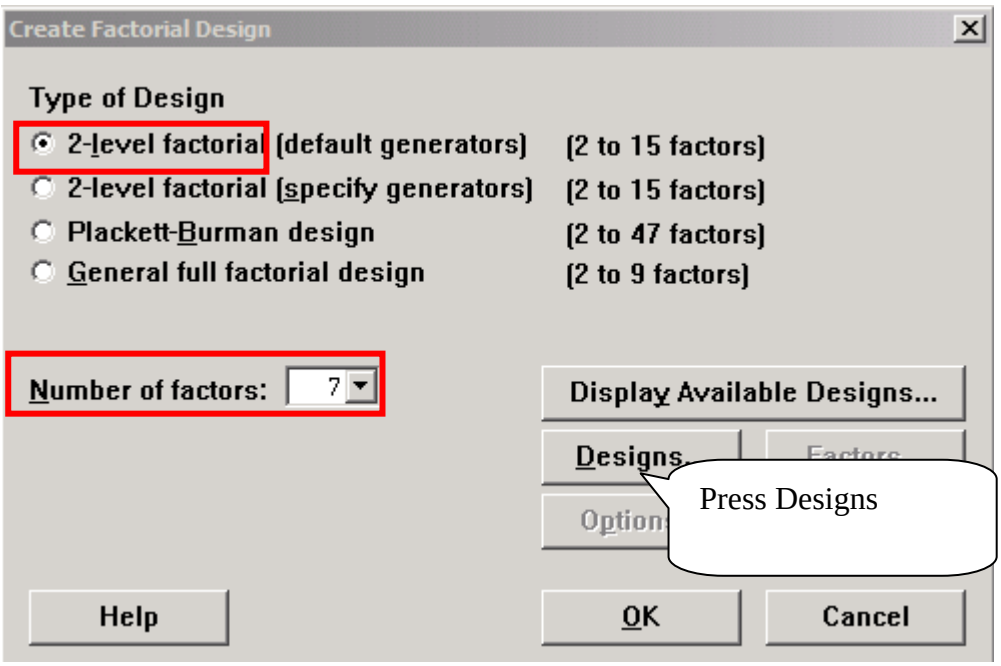
Example 13.11

A. Create Factorial Design

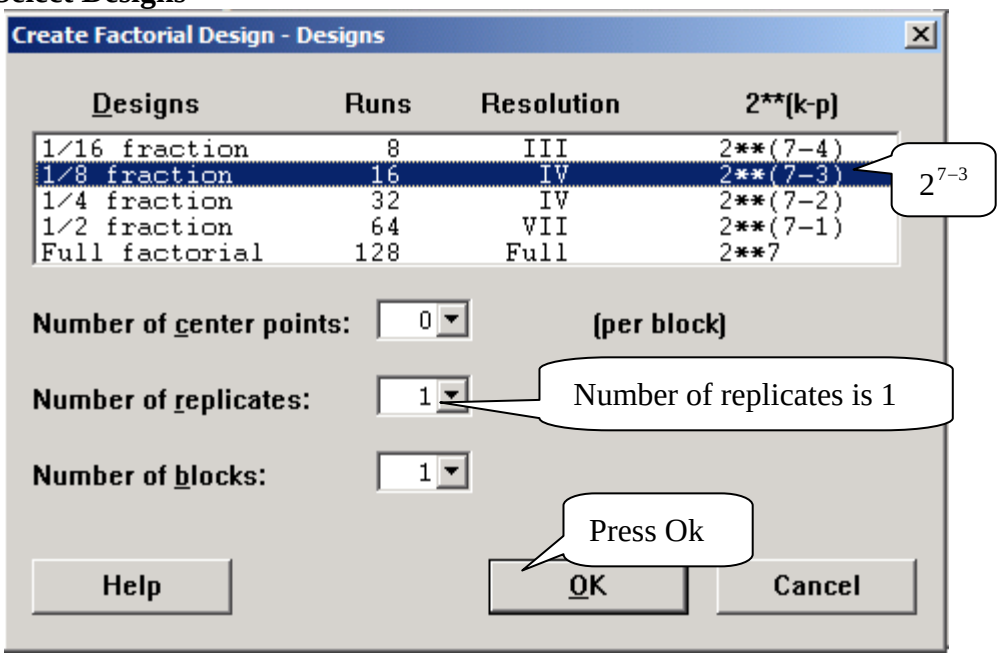
1. Stat>DOE>Factorial>Create Factorial Design



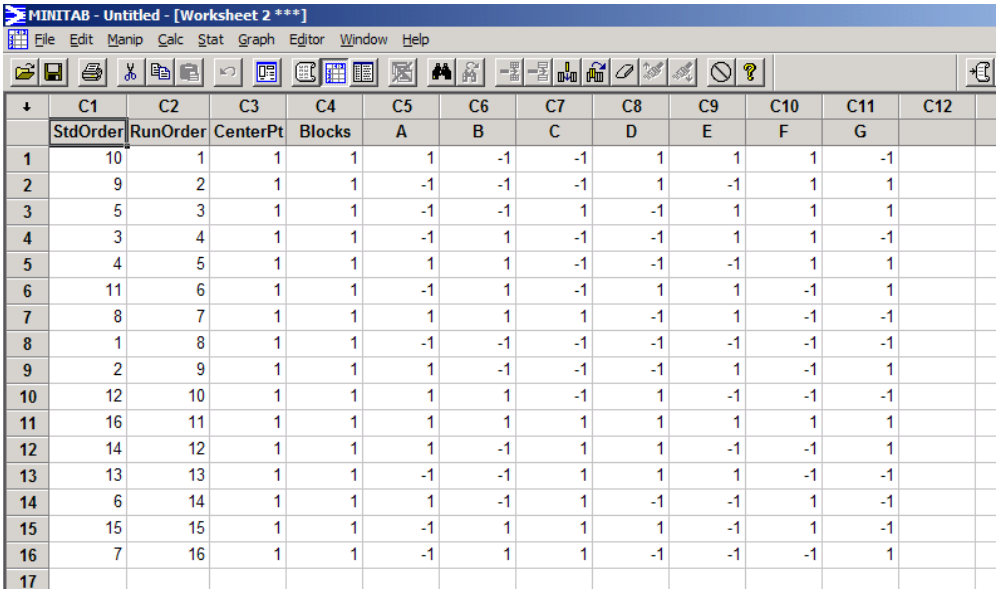
2. 2 levels and 7 factors



3. Select Designs



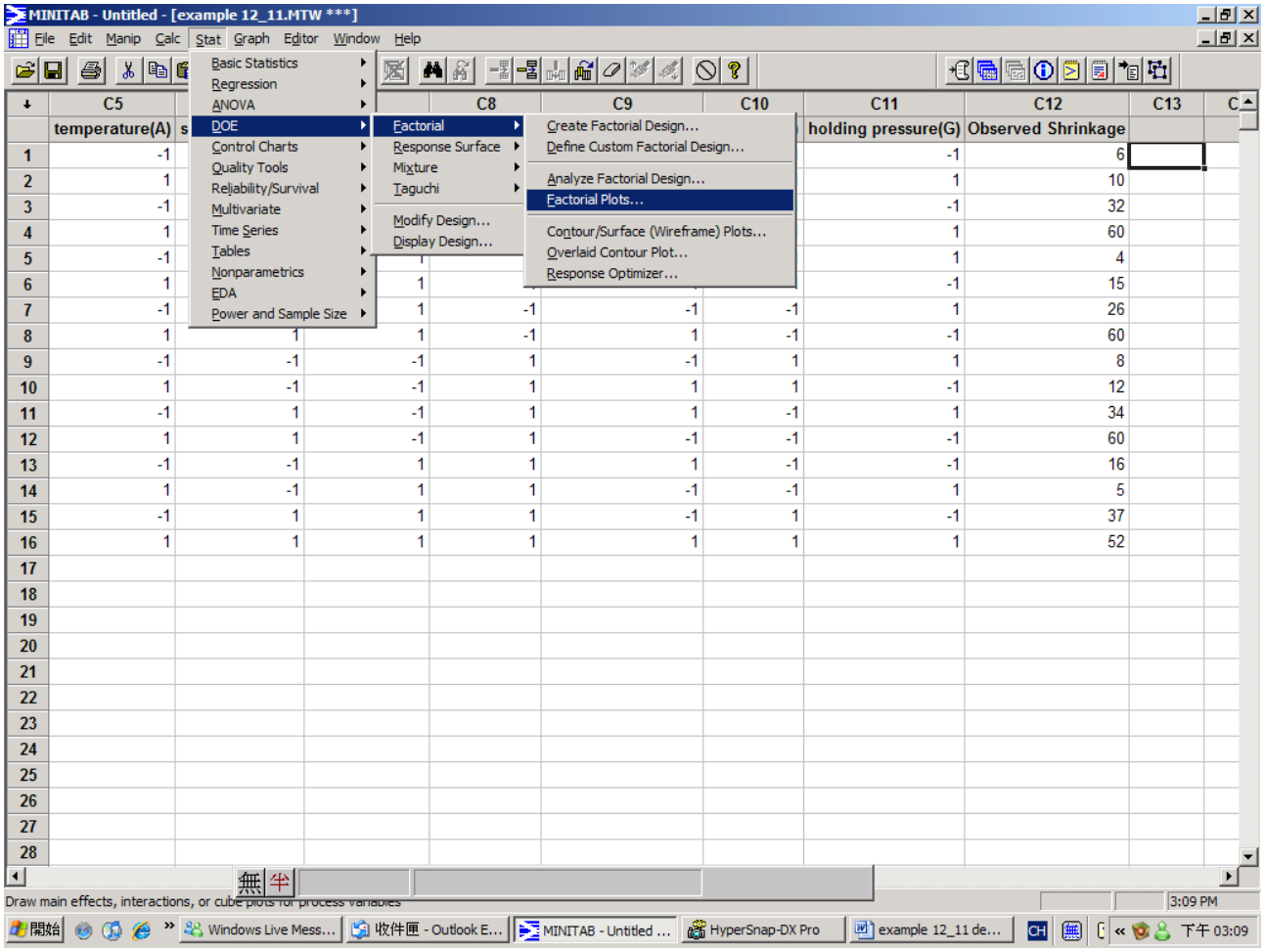
4. You could key the data in column 12.

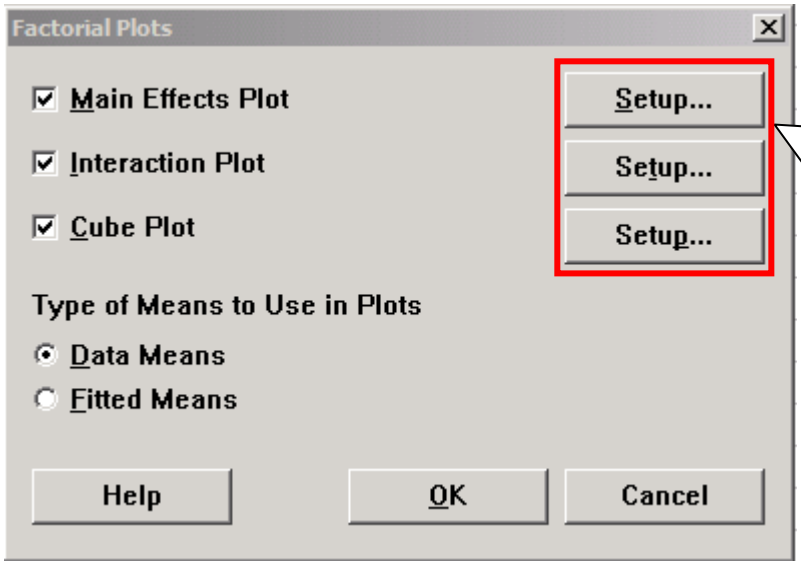


	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
	StdOrder	RunOrder	CenterPt	Blocks	A	B	C	D	E	F	G	
1	10	1	1	1	1	-1	-1	1	1	1	-1	
2	9	2	1	1	-1	-1	-1	1	-1	1	1	
3	5	3	1	1	-1	-1	1	-1	1	1	1	
4	3	4	1	1	-1	1	-1	-1	1	1	-1	
5	4	5	1	1	1	1	-1	-1	-1	1	1	
6	11	6	1	1	-1	1	-1	1	1	-1	1	
7	8	7	1	1	1	1	1	-1	1	-1	-1	
8	1	8	1	1	-1	-1	-1	-1	-1	-1	-1	
9	2	9	1	1	1	-1	-1	-1	1	-1	1	
10	12	10	1	1	1	1	-1	1	-1	-1	-1	
11	16	11	1	1	1	1	1	1	1	1	1	
12	14	12	1	1	1	-1	1	1	-1	-1	1	
13	13	13	1	1	-1	-1	1	1	1	-1	-1	
14	6	14	1	1	1	-1	1	-1	-1	1	-1	
15	15	15	1	1	-1	1	1	1	-1	1	-1	
16	7	16	1	1	-1	1	1	-1	-1	-1	1	
17												

B. Factorial Plots

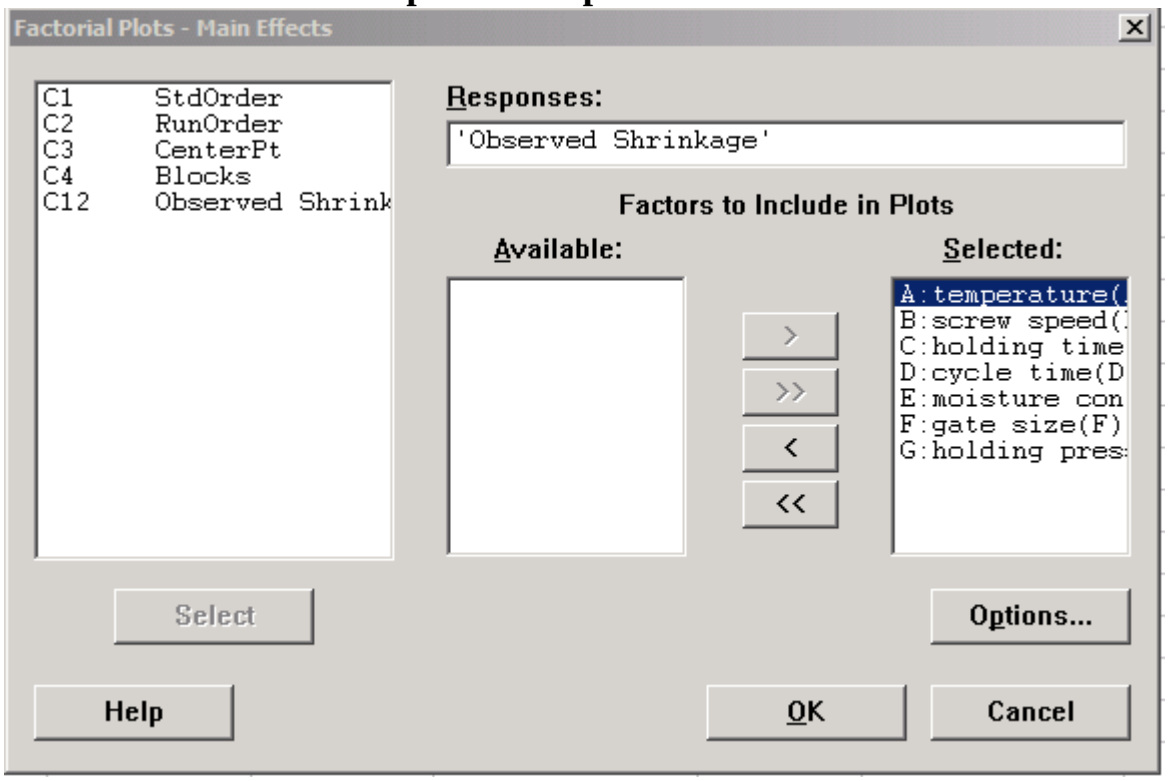
Stat>DOE>Factorial> Factorial Plots





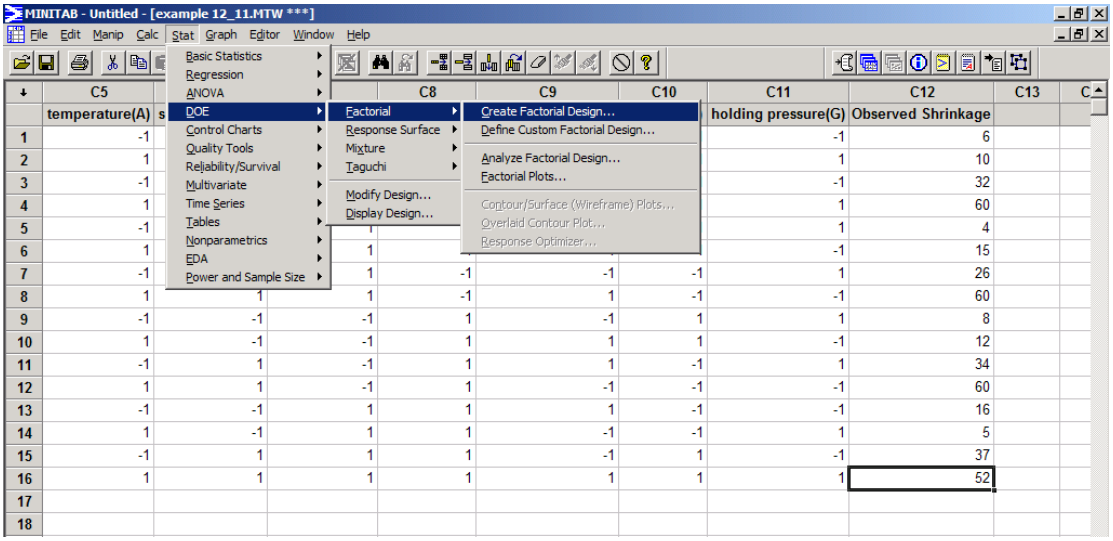
To select which factors you want to plot.

Take “Main Effects –setup” as example

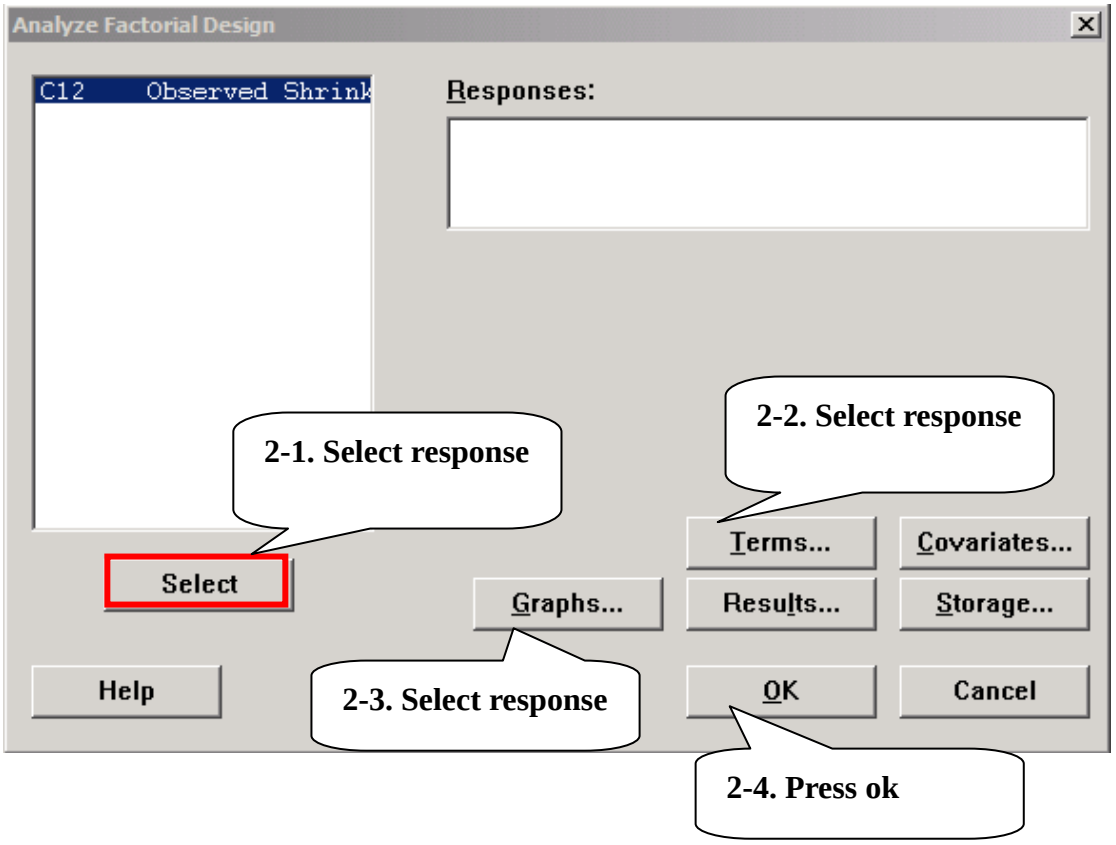


B. Analysis data

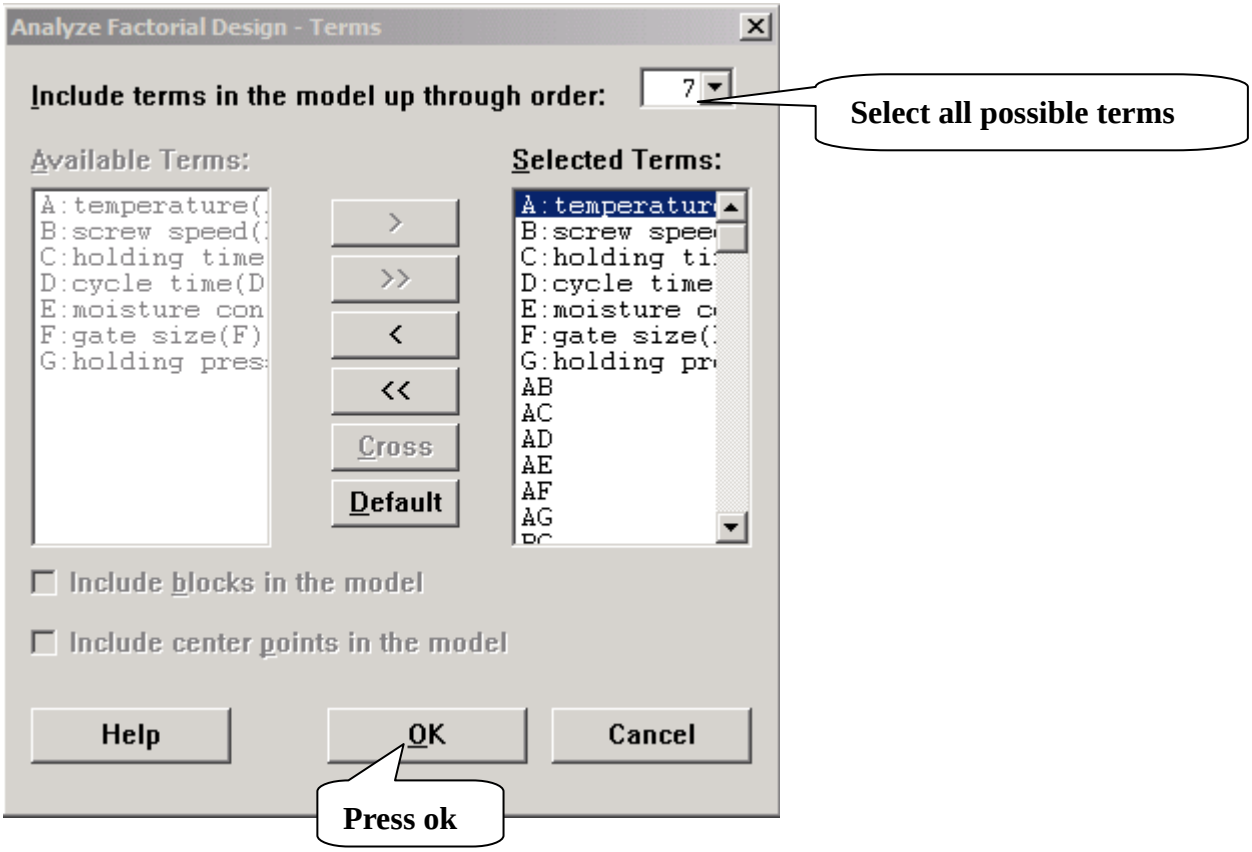
1. Stat>DOE>Factorial>Analyze Factorial Design



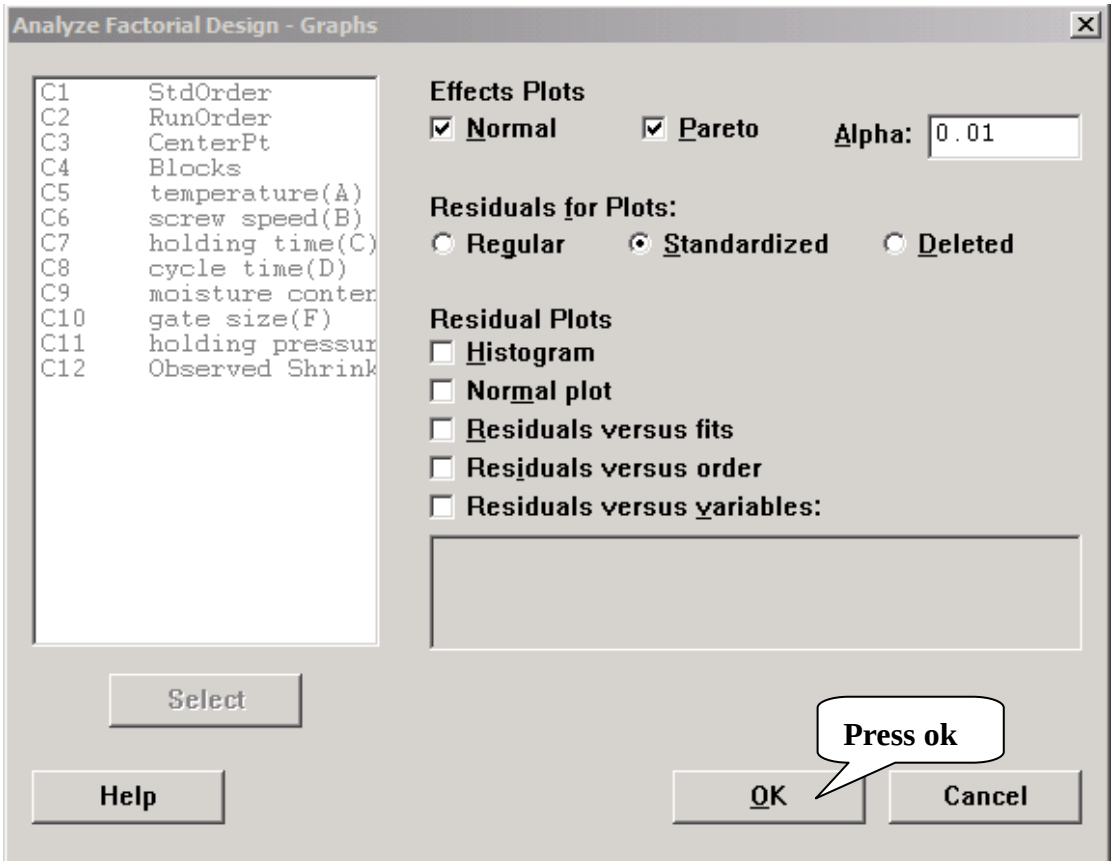
2. Analyze Factorial Design



2-2. Term

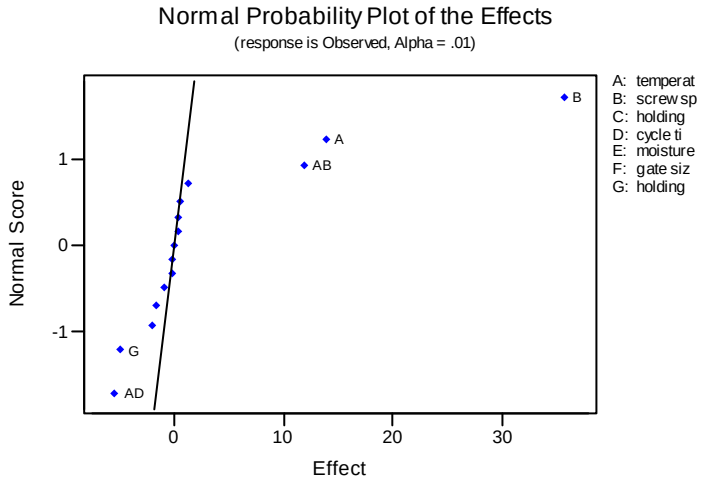


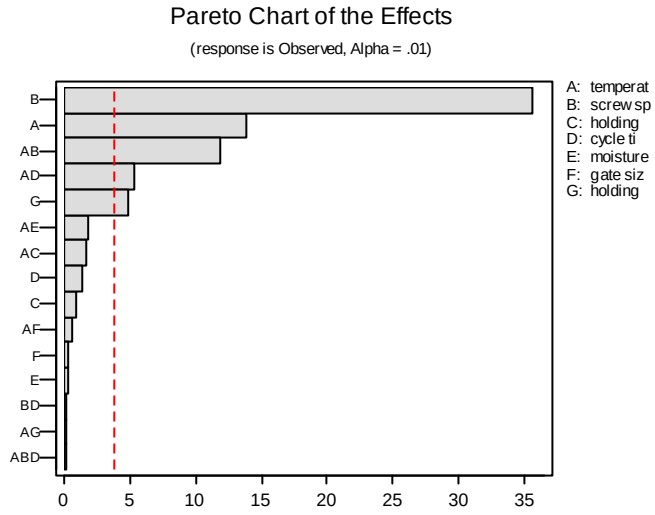
2-3. Graph



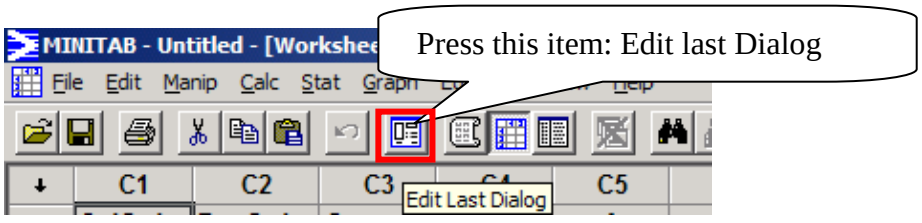
2-4. Press ok

Output 1



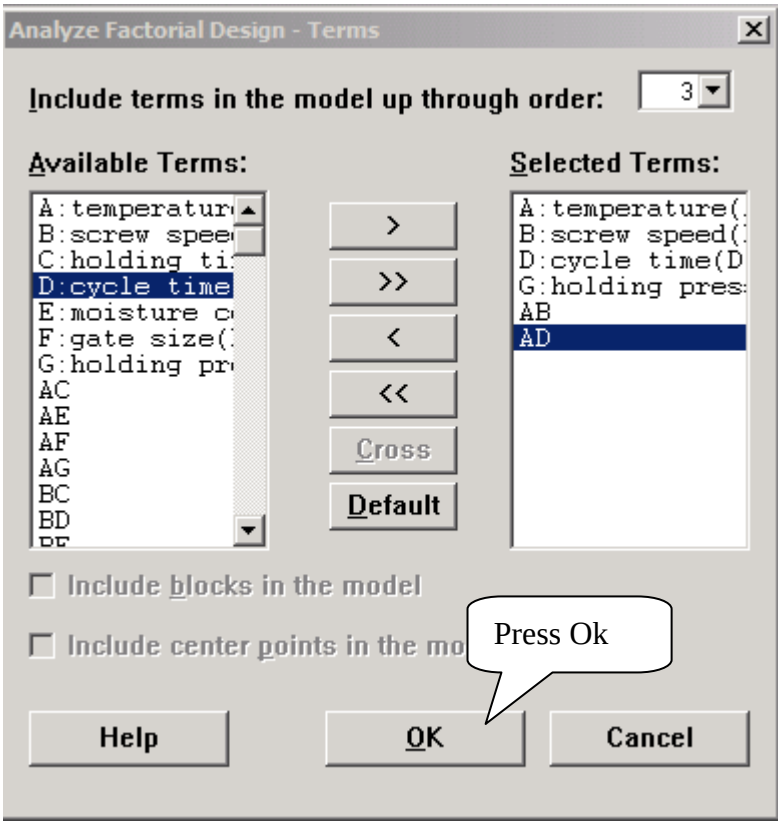


Select **A, B, AB, AD, G,** D (To include the interaction "AD", term D must be selected.)



You will see step "2. Analyze Factorial Design"

2-2 Terms (Select **A, B, AB, AD, G,** D**)**



2-4. Press ok

Output 2

Fractional Factorial Fit: Observed Shr versus temperature(, screw speed(, ...

Estimated Effects and Coefficients for Observed (coded units)

Term	Effect	Coef	SE Coef	T	P
Constant		27.313	0.4607	59.29	0.000
temperat	13.875	6.937	0.4607	15.06	0.000
screw sp	35.625	17.812	0.4607	38.66	0.000
cycle ti	1.375	0.688	0.4607	1.49	0.170
holding	-4.875	-2.437	0.4607	-5.29	0.000
temperat*screw sp	11.875	5.938	0.4607	12.89	0.000
temperat*cycle ti	-5.375	-2.688	0.4607	-5.83	0.000

Analysis of Variance for Observed (coded units)

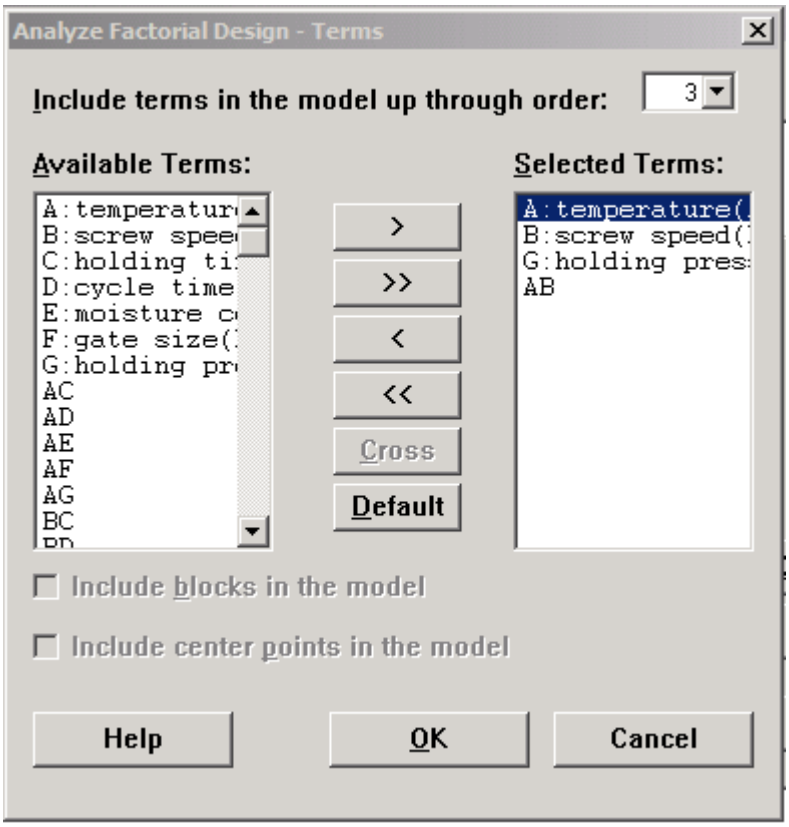
Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	4	5949.25	5949.25	1487.31	437.98	0.000
2-Way Interactions	2	679.63	679.63	339.81	100.07	0.000
Residual Error	9	30.56	30.56	3.40		
Total	15	6659.44				

Alias Structure

I
temperat
screw
cycle
holding
temperat*screw
temperat*cycle

Delete D and AD (Only A, B, G, AB), since p_value of factor D is larger than significant level 0.01.

Go to 2-2 Terms (Select **A, B, G, AB)**



Output 3

Fractional Factorial Fit: Observed Shr versus temperature(, screw speed(, ...

Estimated Effects and Coefficients for Observed (coded units)

Term	Effect	Coef	SE Coef	T	P
Constant		27.313	0.9345	29.23	0.000
temperat	13.875	6.937	0.9345	7.42	0.000
screw sp	35.625	17.812	0.9345	19.06	0.000
holding	-4.875	-2.438	0.9345	-2.61	0.024
temperat*screw sp	11.875	5.938	0.9345	6.35	0.000

Analysis of Variance for Observed (coded units)

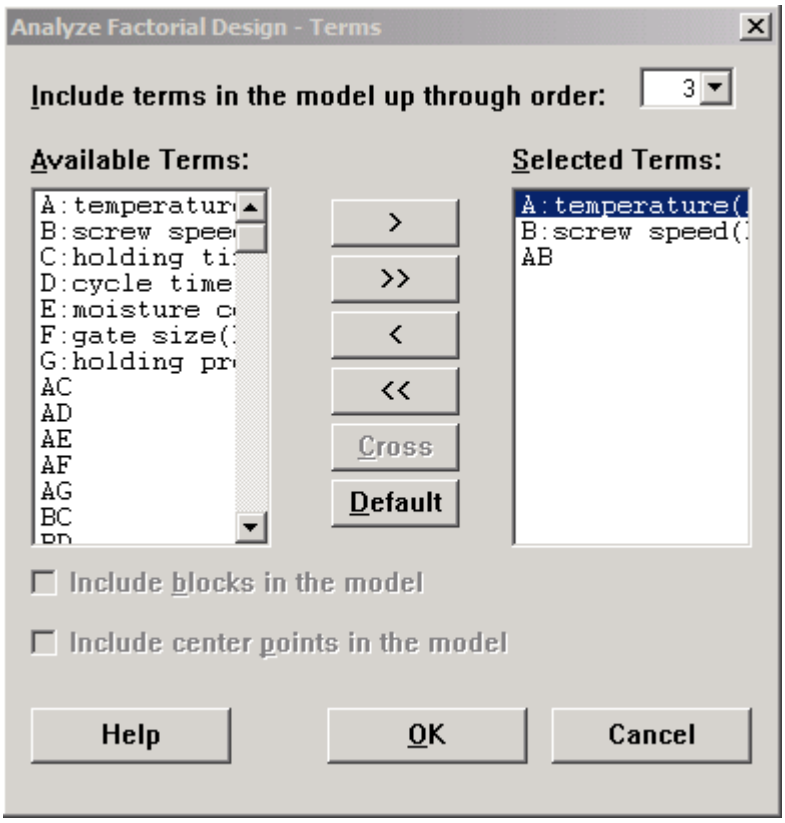
Source	DF	Seq SS	Adj SS	Adj MS	F	P
Main Effects	3	5941.69	5941.69	1980.56	141.76	0.000
2-Way Interactions	1	564.06	564.06	564.06	40.37	0.000
Residual Error	11	153.69	153.69	13.97		
Lack of Fit	3	2.19	2.19	0.73	0.04	0.989
Pure Error	8	151.50	151.50	18.94		
Total	15	6659.44				

Alias Structure

I
temperat
screw
holding
temperat*screw

Delete G (Only A, B, AB), because p_value of D is larger than 0.01

Go to 2-2 Terms (Select A, B, AB**)**



Output 4

Fractional Factorial Fit: Observed Shr versus temperature(, screw speed(

```
Estimated Effects and Coefficients for Observed (coded units)

Term                 Effect      Coef     SE Coef       T      P
Constant                         27.313       1.138   24.00  0.000
temperat             13.875      6.937       1.138    6.09  0.000
screw sp             35.625     17.812       1.138   15.65  0.000
temperat*screw sp    11.875      5.938       1.138    5.22  0.000

Analysis of Variance for Observed (coded units)

Source               DF      Seq SS     Adj SS     Adj MS      F      P
Main Effects          2      5846.6     5846.6    2923.31 141.02  0.000
2-Way Interactions    1       564.1      564.1     564.06  27.21  0.000
Residual Error       12       248.7      248.7      20.73
  Pure Error         12       248.8      248.8      20.73
Total                15      6659.4

Alias Structure

I
temperat
screw
temperat*screw
```

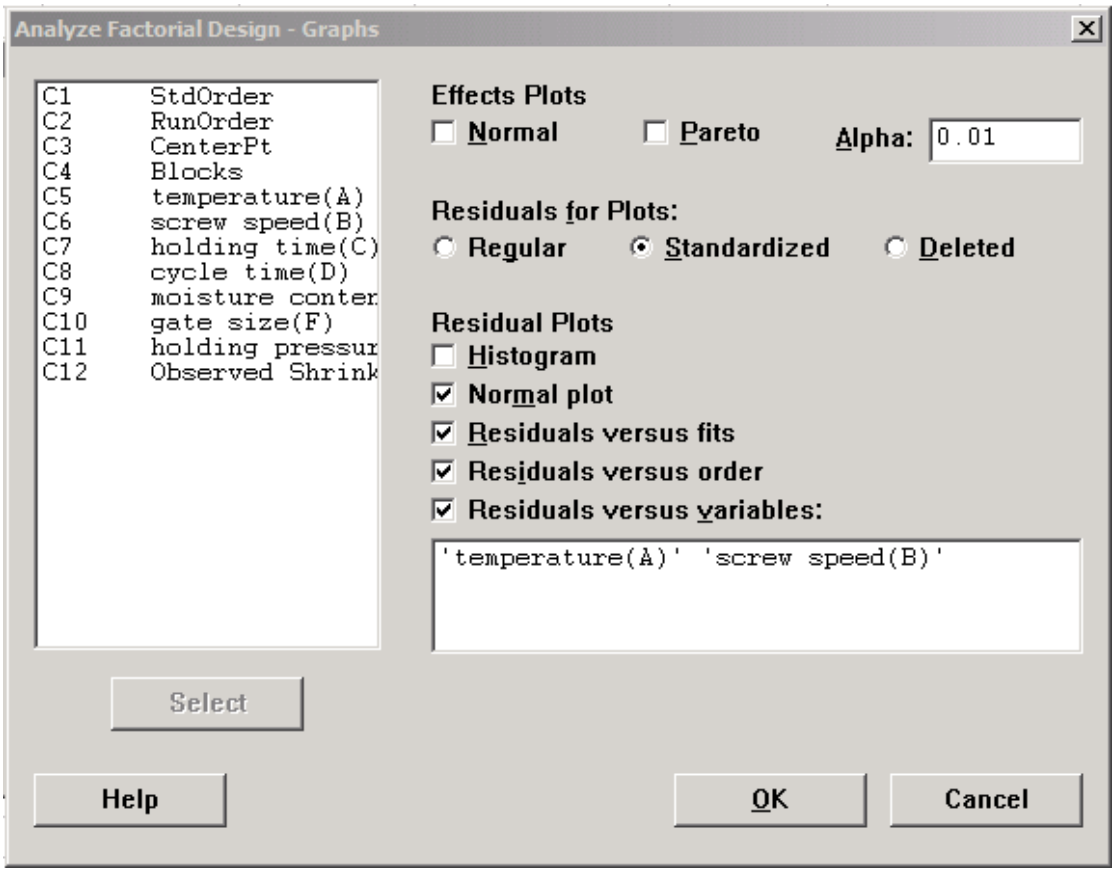
The fitting model for predicted shrinkage (See textbook to get more details)

$\hat{y} = 27.313 + 6.937x_1 + 17.812x_2 + 5.938x_1x_2$

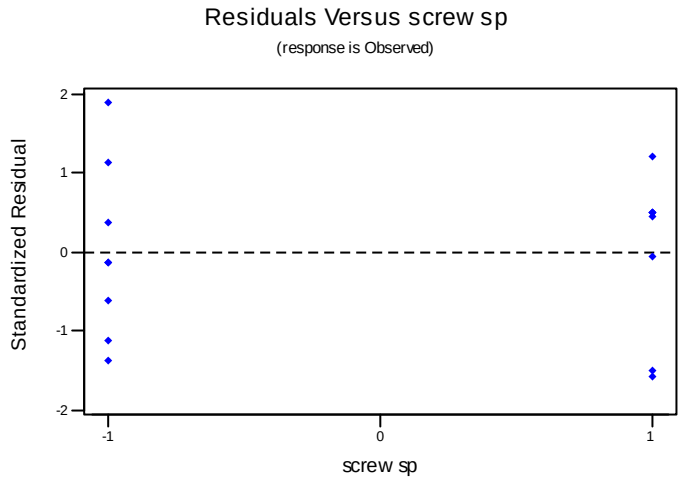
Residual analysis

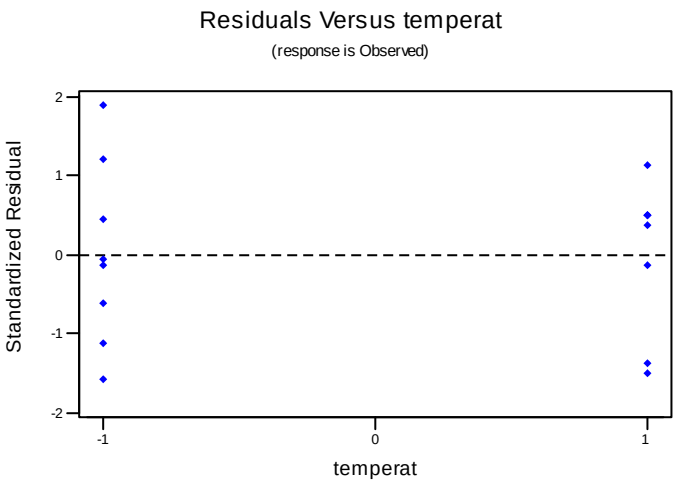
(After you select the final model, you must analyze residuals.)

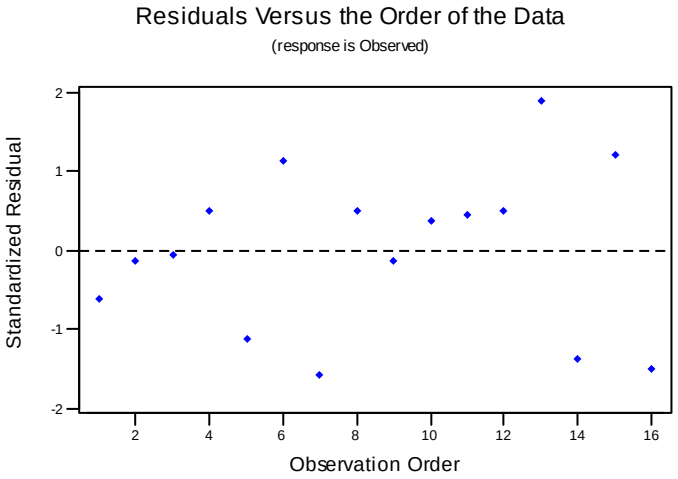
Go to 2-3. Graph

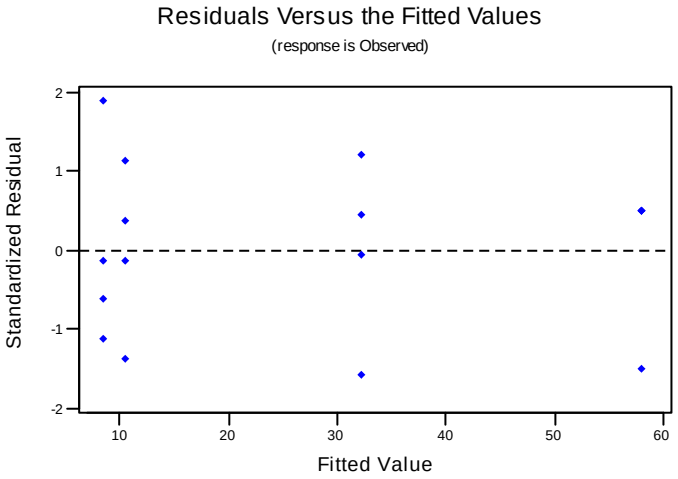


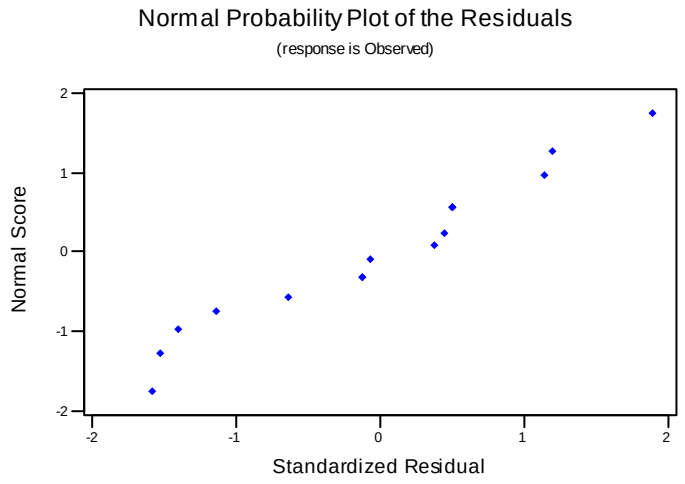
Output 5

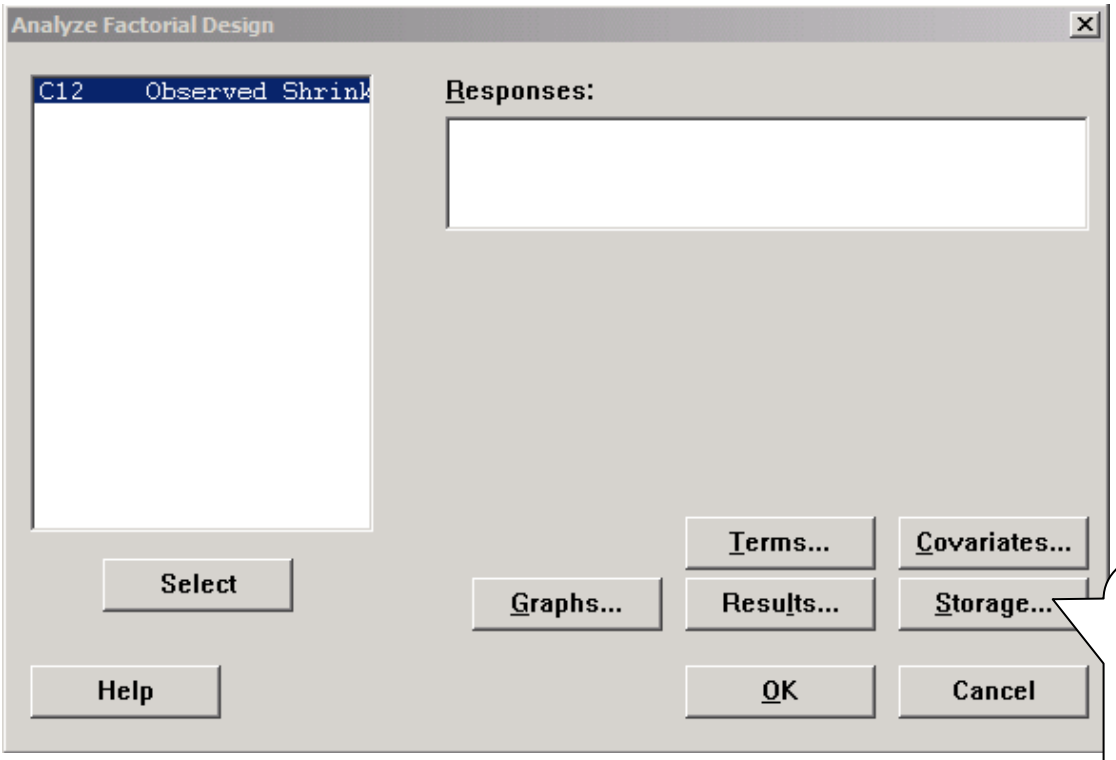



Residuals Versus temperat
(response is Observed)
Standardized Residual
2
1
0
-1
-2
-1
0
1
temperat


Residuals Versus the Order of the Data
(response is Observed)
Standardized Residual
2
1
0
-1
-2
2
4
6
8
10
12
14
16
Observation Order


Residuals Versus the Fitted Values
(response is Observed)
Standardized Residual
2
1
0
-1
-2
10
20
30
40
50
60
Fitted Value





You also can press Storage to store fits, residuals, ….