

```

1 *****;
2 *** EXST7034 Homework Example ***;
3 *** Problem from Neter, Wasserman & Kuttner 1989, Table 9.1 ***;
4 *****;
5
6 OPTIONS LS=133 PS=256 NOCENTER NODATE NONUMBER;
7
8 DATA ONE; INFILE CARDS MISSOEVER;
9 TITLE1 'EXST7034 - Example NWK Table 9.1 : Cafeteria Coffee sales';
10 INPUT Cafeteria X1 Y LINE QUAD CUBE QUAR QUIN SEST;
11 X2=X1*X1; X3=X1*X2; X4=X1*X3; X5=X1*X4; X6=X1*X5; ANOTHERX=X1;
12 D1 = X1 - 3;
13 D2=D1*D1; D3=D1*D2; D4=D1*D3; D5=D1*D4; D6=D1*D5; ANOTHERD=D1;
14 LABEL X1 = 'X : Number of Dispensers';
15 LABEL D1 = 'X - Xmean : Deviation units';
16 LABEL Y = 'Coffee sales (x 100 gals)';
17 LABEL X2 = 'X Squared'; LABEL X3 = 'X Cubed';
18 LABEL X4 = 'X**4'; LABEL X5 = 'X**5'; LABEL X6 = 'X**6';
19 LABEL D2 = 'D Squared'; LABEL D3 = 'D Cubed';
20 LABEL D4 = 'D**4'; LABEL D5 = 'D**5'; LABEL D6 = 'D**6';
21 CARDS;
NOTE: The data set WORK.ONE has 14 observations and 22 variables.
NOTE: DATA statement used: real time 0.10 seconds
21 ! RUN;
36 ;
37 PROC IML;
NOTE: IML Ready
37 ! RESET PRINT;
38 X={0, 1, 2, 3, 4, 5, 6};
39 O=ORPOL(X,3);

39 ! RUN;
NOTE: Module MAIN is undefined in IML; cannot be RUN.
40 QUIT;
NOTE: Exiting IML.
NOTE: The PROCEDURE IML printed page 1.
NOTE: PROCEDURE IML used: real time 0.17 seconds

```

EXST7034 - Example NWK Table 9.1 : Cafeteria Coffee sales

```

X      7 rows      1 col      (numeric)
  0
  1
  2
  3
  4
  5
  6

O      7 rows      4 cols      (numeric)

0.3779645  -0.566947  0.5455447  -0.408248
0.3779645  -0.377964  2.165E-16  0.4082483
0.3779645  -0.188982  -0.327327  0.4082483
0.3779645  -6.97E-17  -0.436436  -3.42E-17
0.3779645  0.1889822  -0.327327  -0.408248
0.3779645  0.3779645  -8.18E-17  -0.408248
0.3779645  0.5669467  0.5455447  0.4082483

```

**The numbers in each column can be multiplied by the value:**

**2.645751122   5.291502711   9.16515182   2.449489686**

**To yield more integer like values in each column:**

<b>1</b>	<b>-3.00000159</b>	<b>5.00000000</b>	<b>-0.99999927</b>
<b>1</b>	<b>-1.99999753</b>	<b>0.00000000</b>	<b>1.00000000</b>
<b>1</b>	<b>-0.99999877</b>	<b>-3.00000165</b>	<b>1.00000000</b>
<b>1</b>	<b>0.00000000</b>	<b>-4.00000220</b>	<b>0.00000000</b>
<b>1</b>	<b>0.99999982</b>	<b>-3.00000165</b>	<b>-0.99999927</b>
<b>1</b>	<b>2.00000018</b>	<b>0.00000000</b>	<b>-0.99999927</b>
<b>1</b>	<b>3.00000000</b>	<b>5.00000000</b>	<b>1.00000000</b>

**EXST7034 : Regression Techniques**  
**Polynomial Regression**

```
42      PROC PRINT DATA=ONE; VAR X1 Y D1 D2 D3 LINE QUAD CUBE QUAR QUIN SEST;
43      TITLE2 'Raw Data Listing'; RUN;
NOTE: There were 14 observations read from the data set WORK.ONE.
NOTE: The PROCEDURE PRINT printed page 2.
NOTE: PROCEDURE PRINT used:      real time      0.04 seconds
```

EXST7034 - Example NWK Table 9.1 : Cafeteria Coffee sales

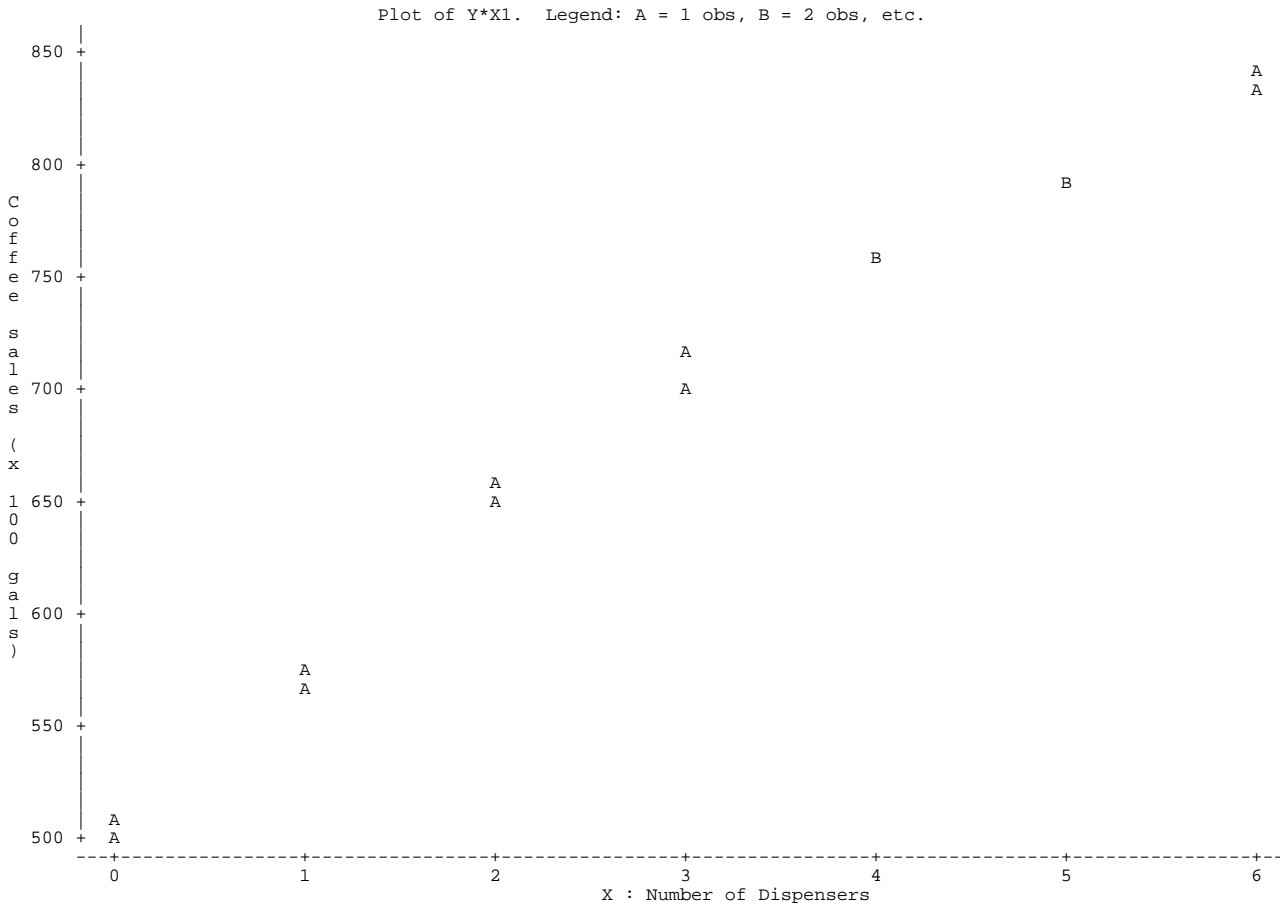
Raw Data Listing

Obs	X1	Y	D1	D2	D3	LINE	QUAD	CUBE	QUAR	QUIN	SEST
1	0	508.1	-3	9	-27	-3	5	1	3	-1	1
2	0	498.4	-3	9	-27	-3	5	1	3	-1	1
3	1	568.2	-2	4	-8	-2	0	-1	-7	4	-6
4	1	577.3	-2	4	-8	-2	0	-1	-7	4	-6
5	2	651.7	-1	1	-1	-1	-3	-1	1	-5	15
6	2	657.0	-1	1	-1	-1	-3	-1	1	-5	15
7	3	713.4	0	0	0	0	-4	0	6	0	-20
8	3	697.5	0	0	0	0	-4	0	6	0	-20
9	4	755.3	1	1	1	1	-3	1	1	5	15
10	4	758.9	1	1	1	1	-3	1	1	5	15
11	5	787.6	2	4	8	2	0	1	-7	-4	-6
12	5	792.1	2	4	8	2	0	1	-7	-4	-6
13	6	841.4	3	9	27	3	5	-1	3	1	1
14	6	831.8	3	9	27	3	5	-1	3	1	1

```
44      OPTIONS PS=55; PROC PLOT DATA=ONE; PLOT Y*X1; RUN; OPTIONS PS=256;
NOTE: There were 14 observations read from the data set WORK.ONE.
NOTE: The PROCEDURE PLOT printed page 3.
NOTE: PROCEDURE PLOT used:      real time      0.00 seconds
```

EXST7034 - Example NWK Table 9.1 : Cafeteria Coffee sales

Raw Data Listing



**EXST7034 : Regression Techniques**  
**Polynomial Regression**

```

45      PROC REG DATA=ONE; TITLE2 'Fits of levels of Deviation units as a polynomial';
46          Quadratic:MODEL Y= D1 D2 / SS1 SS2;
47          Sestic:MODEL Y = D1 D2 D3 D4 D5 D6 / SS1 SS2; RUN;
NOTE: 14 observations read.
NOTE: 14 observations used in computations.
NOTE: The PROCEDURE REG printed pages 4-5.
NOTE: PROCEDURE REG used:          real time          0.26 seconds

```

EXST7034 - Example NWK Table 9.1 : Cafeteria Coffee sales  
Fits of levels of Deviation units as a polynomial

The REG Procedure  
Model: Quadratic  
Dependent Variable: Y Coffee sales (x 100 gals)

Analysis of Variance						
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F	
Model	2	171773	85887	1390.94	<.0001	
Error	11	679.22048	61.74732			
Corrected Total	13	172453				
Root MSE	7.85795	R-Square	0.9961			
Dependent Mean	688.47857	Adj R-Sq	0.9953			
Coeff Var	1.14135					

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr >  t	Type I SS	Type II SS
Intercept	Intercept	1	705.47381	3.20799	219.91	<.0001	6636038	2986160
D1	X - Xmean : Deviation units	1	54.89286	1.05006	52.28	<.0001	168741	168741
D2	D Squared	1	-4.24881	0.60625	-7.01	<.0001	3032.80024	3032.80024

EXST7034 - Example NWK Table 9.1 : Cafeteria Coffee sales  
Fits of levels of Deviation units as a polynomial

The REG Procedure  
Model: Sestic  
Dependent Variable: Y Coffee sales (x 100 gals)

Analysis of Variance						
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F	
Model	6	172161	28694	688.84	<.0001	
Error	7	291.58500	41.65500			
Corrected Total	13	172453				
Root MSE	6.45407	R-Square	0.9983			
Dependent Mean	688.47857	Adj R-Sq	0.9969			
Coeff Var	0.93744					

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr >  t	Type I SS	Type II SS
Intercept	Intercept	1	705.45000	4.56372	154.58	<.0001	6636038	995319
D1	X - Xmean : Deviation units	1	50.05333	4.93759	10.14	<.0001	168741	4280.59337
D2	D Squared	1	3.64028	7.89000	0.46	0.6585	3032.80024	8.86712
D3	D Cubed	1	1.41042	2.05684	0.69	0.5150	60.75000	19.58671
D4	D**4	1	-3.68056	2.54883	-1.44	0.1920	204.54870	86.85838
D5	D**5	1	-0.08875	0.17428	-0.51	0.6262	10.80214	10.80214
D6	D**6	1	0.31528	0.19267	1.64	0.1458	111.53463	111.53463

**EXST7034 : Regression Techniques**  
**Polynomial Regression**

```
48      PROC REG DATA=ONE; TITLE2 'Fits of levels of the original X as a polynomial';
49      Quadratic:MODEL Y= X1 X2 / SS1 SS2;
50      Sestic:MODEL Y = X1 X2 X3 X4 X5 X6 / SS1 SS2; RUN;
NOTE: 14 observations read.
NOTE: 14 observations used in computations.
NOTE: The PROCEDURE REG printed pages 6-7.
NOTE: PROCEDURE REG used:      real time      0.00 seconds
```

EXST7034 - Example NWK Table 9.1 : Cafeteria Coffee sales  
 Fits of levels of the original X as a polynomial

The REG Procedure  
 Model: Quadratic  
 Dependent Variable: Y Coffee sales (x 100 gals)

Analysis of Variance						
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F	
Model	2	171773	85887	1390.94	<.0001	
Error	11	679.22048	61.74732			
Corrected Total	13	172453				
Root MSE	7.85795	R-Square	0.9961			
Dependent Mean	688.47857	Adj R-Sq	0.9953			
Coeff Var	1.14135					

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr >  t	Type I SS	Type II SS
Intercept	Intercept	1	502.55595	4.85003	103.62	<.0001	6636038	662977
X1	X : Number of Dispensers	1	80.38571	3.78605	21.23	<.0001	168741	27836
X2	X Squared	1	-4.24881	0.60625	-7.01	<.0001	3032.80024	3032.80024

EXST7034 - Example NWK Table 9.1 : Cafeteria Coffee sales  
 Fits of levels of the original X as a polynomial

The REG Procedure  
 Model: Sestic  
 Dependent Variable: Y Coffee sales (x 100 gals)

Analysis of Variance						
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F	
Model	6	172161	28694	688.84	<.0001	
Error	7	291.58500	41.65500			
Corrected Total	13	172453				
Root MSE	6.45407	R-Square	0.9983			
Dependent Mean	688.47857	Adj R-Sq	0.9969			
Coeff Var	0.93744					

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr >  t	Type I SS	Type II SS
Intercept	Intercept	1	503.25000	4.56372	110.27	<.0001	6636038	506521
X1	X : Number of Dispensers	1	-31.82583	57.40625	-0.55	0.5966	168741	12.80290
X2	X Squared	1	199.22153	108.88923	1.83	0.1100	3032.80024	139.43435
X3	X Cubed	1	-132.66042	74.86717	-1.77	0.1197	60.75000	130.78775
X4	X**4	1	40.21319	23.61725	1.70	0.1324	204.54870	120.76628
X5	X**5	1	-5.76375	3.47250	-1.66	0.1409	10.80214	114.76064
X6	X**6	1	0.31528	0.19267	1.64	0.1458	111.53463	111.53463

## Polynomial Regression

```

51      PROC REG DATA=ONE; TITLE2 'Orthogonal polynomial variables';
52      MODEL Y = LINE QUAD CUBE QUAR QUIN SEST / SS1 SS2; RUN;
NOTE: 14 observations read.
NOTE: 14 observations used in computations.
NOTE: The PROCEDURE REG printed page 8.
NOTE: PROCEDURE REG used:          real time          0.05 seconds

```

EXST7034 - Example NWK Table 9.1 : Cafeteria Coffee sales  
Orthogonal polynomial variables

The REG Procedure

Model: MODEL1

Dependent Variable: Y Coffee sales (x 100 gals)

Analysis of Variance						
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F	
Model	6	172161	28694	688.84	<.0001	
Error	7	291.58500	41.65500			
Corrected Total	13	172453				
Root MSE	6.45407	R-Square	0.9983			
Dependent Mean	688.47857	Adj R-Sq	0.9969			
Coeff Var	0.93744					

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr >  t	Type I SS	Type II SS
Intercept	Intercept	1	688.47857	1.72492	399.14	<.0001	6636038	6636038
LINE		1	54.89286	0.86246	63.65	<.0001	168741	168741
QUAD		1	-4.24881	0.49794	-8.53	<.0001	3032.80024	3032.80024
CUBE		1	-2.25000	1.86313	-1.21	0.2664	60.75000	60.75000
QUAR		1	0.81494	0.36775	2.22	0.0622	204.54870	204.54870
QUIN		1	-0.25357	0.49794	-0.51	0.6262	10.80214	10.80214
SEST		1	0.24567	0.15014	1.64	0.1458	111.53463	111.53463

```

53      PROC REG DATA=ONE; TITLE2 'Lack of Fit with PROC REG';
54      MODEL Y = X1 X2 X3 X4 X5 X6 / SS1 SS2;
55      Linear:test X2=0, X3=0, X4=0, X5=0, X6=0;
56      Quadratic:test X3=0, X4=0, X5=0, X6=0;
57      Cubic:test X4=0, X5=0, X6=0;
58      Quartic:test X5=0, X6=0;
59      RUN;
NOTE: 14 observations read.
NOTE: 14 observations used in computations.
NOTE: The PROCEDURE REG printed pages 9-13.
NOTE: PROCEDURE REG used:          real time          0.00 seconds

```

**EXST7034 : Regression Techniques**  
**Polynomial Regression**

EXST7034 - Example NWK Table 9.1 : Cafeteria Coffee sales  
 Lack of Fit with PROC REG

The REG Procedure

Model: MODEL1

Dependent Variable: Y Coffee sales (x 100 gals)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	172161	28694	688.84	<.0001
Error	7	291.58500	41.65500		
Corrected Total	13	172453			

Root MSE	6.45407	R-Square	0.9983
Dependent Mean	688.47857	Adj R-Sq	0.9969
Coeff Var	0.93744		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr >  t	Type I SS	Type II SS
Intercept	Intercept	1	503.25000	4.56372	110.27	<.0001	6636038	506521
X1	X : Number of Dispensers	1	-31.82583	57.40625	-0.55	0.5966	168741	12.80290
X2	X Squared	1	199.22153	108.88923	1.83	0.1100	3032.80024	139.43435
X3	X Cubed	1	-132.66042	74.86717	-1.77	0.1197	60.75000	130.78775
X4	X**4	1	40.21319	23.61725	1.70	0.1324	204.54870	120.76628
X5	X**5	1	-5.76375	3.47250	-1.66	0.1409	10.80214	114.76064
X6	X**6	1	0.31528	0.19267	1.64	0.1458	111.53463	111.53463

Test Linear Results for Dependent Variable Y

Source	DF	Mean Square	F Value	Pr > F
Numerator	5	684.08714	16.42	0.0010
Denominator	7	41.65500		

Test Quadratic Results for Dependent Variable Y

Source	DF	Mean Square	F Value	Pr > F
Numerator	4	96.90887	2.33	0.1554
Denominator	7	41.65500		

Test Cubic Results for Dependent Variable Y

Source	DF	Mean Square	F Value	Pr > F
Numerator	3	108.96183	2.62	0.1330
Denominator	7	41.65500		

Test Quartic Results for Dependent Variable Y

Source	DF	Mean Square	F Value	Pr > F
Numerator	2	61.16839	1.47	0.2934
Denominator	7	41.65500		

```
60 PROC mixed DATA=ONE; CLASSES X1;
61 TITLE2 'Demonstration of Orthogonal Polynomial contrasts PROC MIXED';
62 MODEL Y = X1 / Htype=1 2 3;
63 CONTRAST 'OrPol: Linear' X1 -3 -2 -1 0 1 2 3;
64 CONTRAST 'OrPol: Quadratic' X1 -5 0 3 4 3 0 -5;
65 CONTRAST 'OrPol: Cubic' X1 1 -1 -1 0 1 1 -1;
66 CONTRAST 'OrPol: Quartic' X1 3 -7 1 6 1 -7 3;
67 CONTRAST 'OrPol: Quintic' X1 1 -4 5 0 -5 4 -1;
68 CONTRAST 'OrPol: Sestic' X1 1 -6 15 -20 15 -6 1; RUN;
```

NOTE: The PROCEDURE MIXED printed page 14.

NOTE: PROCEDURE MIXED used: real time 0.05 seconds

**EXST7034 : Regression Techniques**  
**Polynomial Regression**

EXST7034 - Example NWK Table 9.1 : Cafeteria Coffee sales  
 Demonstration of Orthogonal Polynomial contrasts PROC MIXED

The Mixed Procedure

Model Information	
Data Set	WORK.ONE
Dependent Variable	Y
Covariance Structure	Diagonal
Estimation Method	REML
Residual Variance Method	Profile
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Residual

Class Level Information		
Class	Levels	Values
X1	7	0 1 2 3 4 5 6

Dimensions	
Covariance Parameters	1
Columns in X	8
Columns in Z	0
Subjects	1
Max Obs Per Subject	14
Observations Used	14
Observations Not Used	0
Total Observations	14

Covariance Parameter Estimates	
Cov Parm	Estimate
Residual	41.6550

Fit Statistics	
-2 Res Log Likelihood	50.8
AIC (smaller is better)	52.8
AICC (smaller is better)	53.6
BIC (smaller is better)	52.8

Type 1 Tests of Fixed Effects				
Effect	DF	DF	F Value	Pr > F
X1	6	7	688.84	<.0001

Type 2 Tests of Fixed Effects				
Effect	DF	DF	F Value	Pr > F
X1	6	7	688.84	<.0001

Type 3 Tests of Fixed Effects				
Effect	DF	DF	F Value	Pr > F
X1	6	7	688.84	<.0001

Contrasts				
Label	DF	DF	F Value	Pr > F
OrPol: Linear	1	7	4050.91	<.0001
OrPol: Quadratic	1	7	72.81	<.0001
OrPol: Cubic	1	7	1.46	0.2664
OrPol: Quartic	1	7	4.91	0.0622
OrPol: Quintic	1	7	0.26	0.6262
OrPol: Sestic	1	7	2.68	0.1458