

```

proc GLM data=Satisfaction; TITLE2 'Analysis with GLM';
  MODEL Y=X2 X1 X3;
RUN;

proc REG data=Satisfaction; TITLE2 'Analysis with REG';
  MODEL Y=X1 X2 X3 / vif stb PCORR1 PCORR2 SCORR1 SCORR2;
  TEST X2=X3=0;
  TEST X1=-1, X2=0;
RUN;

proc REG data=Satisfaction; TITLE2 'Analysis with REG';
  MODEL Y=X1 X2 X3;
  restrict X1=-1, X2=0;
RUN;

proc REG data=Satisfaction; TITLE2 'Analysis with REG';
  MODEL Y=X1 / vif stb PCORR1 PCORR2 SCORR1 SCORR2;
RUN;

proc REG data=Satisfaction; TITLE2 'Analysis with REG';
  MODEL Y=X1 X2 / vif stb PCORR1 PCORR2 SCORR1 SCORR2;
RUN;

proc REG data=Satisfaction; TITLE2 'Analysis with REG';
  MODEL Y=X2 / vif stb PCORR1 PCORR2 SCORR1 SCORR2;
RUN;
    
```

Question 7.5a from KNNL: The model was fitted with GLM. The appropriate SS are given by the TYPE I SS with the model fitted as “Y=X2 X1 X3;”

Dependent Variable: Y

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	9120.46367	3040.15456	30.05	<.0001
Error	42	4248.84068	101.16287		
Corrected Total	45	13369.30435			

R-Square	Coeff Var	Root MSE	Y Mean
0.682194	16.33711	10.05798	61.56522

Source	DF	Type I SS	Mean Square	F Value	Pr > F
X2	1	4860.260003	4860.260003	48.04	<.0001
X1	1	3896.044142	3896.044142	38.51	<.0001
X3	1	364.159521	364.159521	3.60	0.0647

Question 7.5b from KNNL: Using the output from question 7.5a above, the test shows that after adjusting for X2 and X1 (order not important to testing X3 as long as it is last), X3 has an F value of only 3.60, which is not significant at the 0.025 level specified by the problem. It can be dropped.

Question 7.6 from KNNL: The model fitted with REG was presented previously. This hypothesis was tested with a test statement: TEST X2=X3=0;. The test results indicate that the two variables, X2 and X3 should both be retained in the model (P=0.0222).

**The REG Procedure**

**Model: MODEL1**

**Test 1 Results for Dependent Variable Y**

Source	DF	Mean Square	F Value	Pr > F
Numerator	2	422.53741	4.18	0.0222
Denominator	42	101.16287		

Question 7.9 from KNNL: Question 7.6 from KNNL: The full model was fitted with GLM was presented above. A reduced model with the restrictions model  $X_1=-1$  and  $X_2=0$  can be fitted with the following statements.

```
proc REG data=Satisfaction; TITLE2 'Analysis with REG';
  MODEL Y=X1 X2 X3;
  restrict X1=-1, X2=0;
RUN;
```

The results of this fit are given below. This is a reduced model, and the difference from the full model (GLM above) can be tested with the general linear hypothesis test. Note the values of the regressions coefficients showing the restrictions.

**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	8941.64940	8941.64940	88.86	<.0001
Error	44	4427.65495	100.62852		
Corrected Total	45	13369			

**Parameter Estimates**

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr >  t
Intercept	1	146.02609	11.52015	12.68	<.0001
X1	1	-1.00000	0	-Infty	<.0001
X2	1	8.9013E-17	0	Infty	<.0001
X3	1	-20.14449	4.99564	-4.03	0.0002
RESTRICT	-1	-484.63360	493.22037	-0.98	0.3315*
RESTRICT	-1	-249.28359	215.34660	-1.16	0.2516*

\* Probability computed using beta distribution.

This hypothesis can also be tested with a test statement on the full model in PROC REG by “**TEST X1=-1, X2=0;**”. This test had been done in a previous assignment as a supplemental part of question 6.15c. The test results were:

**Test 2 Results for Dependent Variable Y**

Source	DF	Mean Square	F Value	Pr > F
Numerator	2	89.40713	0.88	0.4208
Denominator	42	101.16287		

The hypotheses were  $H_0: \beta_1 = -1$  and  $\beta_2 = 0$ . The decision rule is simply  $P \leq 0.025$ . Conclusion: Cannot reject  $H_0$ .

Question 7.14a from KNNL: The model was fitted with REG, and the PCORR1, PCORR2, SCORR1 and SCORR2 options were requested (among other things). The results were.

Model: Y on X1		Squared	Squared	Squared	Squared
		Semi-partial	Partial	Semi-partial	Partial
Variable	DF	Corr Type I	Corr Type I	Corr Type II	Corr Type II
X1	1	0.61898	0.61898	0.61898	<b>0.61898</b>

Model: Y on X1&X2		Squared	Squared	Squared	Squared
		Semi-partial	Partial	Semi-partial	Partial
Variable	DF	Corr Type I	Corr Type I	Corr Type II	Corr Type II
X1	1	0.61898	0.61898	0.29142	<b>0.45787</b>
X2	1	0.03597	0.09441	0.03597	0.09441

Model: Y on X1&X2&X3		Squared	Squared	Squared	Squared
		Semi-partial	Partial	Semi-partial	Partial
Variable	DF	Corr Type I	Corr Type I	Corr Type II	Corr Type II
X1	1	0.61898	0.61898	0.21374	<b>0.40211</b>
X2	1	0.03597	0.09441	0.00611	0.01886
X3	1	0.02724	0.07894	0.02724	0.07894

Question 7.14b from KNNL: The model was fitted as above. The only new model needed was the first one (Y on X2).

Model: Y on X1		Squared	Squared	Squared	Squared
		Semi-partial	Partial	Semi-partial	Partial
Variable	DF	Corr Type I	Corr Type I	Corr Type II	Corr Type II
X2	1	0.36354	0.36354	0.36354	<b>0.36354</b>

From above: X2   X1	1	0.03597	0.09441	0.03597	<b>0.09441</b>
From above: X2   X1, X3	1	0.03597	0.09441	0.00611	<b>0.01886</b>

Concerning problem 7.14a&b) NOTE that SAS provides various types of R, but no single regression model provides all of the requested r1, r1.2, and r1.2,3 (since each requested value represents a different model). The values provided by SAS are;

- 1) Semi-partial r (TYPE I) = SSTYPE I / SSTotal
  - 2) Partial r (TYPE I) = SSTYPE I / (\*SSTYPE I SSE)
  - 3) Semi-partial r (TYPE II) = SSTYPE II / SSTotal
  - 4) Partial r (TYPE II) = SSTYPE II / (SSTYPE II SSE); the most common type
- \* Indicates cumulative for equal and higher rank. (e.g. SSTYPE I for X1=SS1X1+SS1X2+SS1X3)

Note that for this example the variable X1 (**0.61898, 0.45787, 0.40211**) was relatively stable and unaffected by additional variables added to the model. The variable X2 (**0.36354, 0.09441, 0.01886**) was greatly influenced.

4) Modified Question 7.18a from KNNL: The standardized regression coefficients are given below. The first variable is several times more important to the model than the other two. The second and third variables are of similar importance to the model.

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr >  t	Standardized Estimate
Intercept	1	158.49125	18.12589	8.74	<.0001	0
X1	1	-1.14161	0.21480	-5.31	<.0001	<b>-0.59067</b>
X2	1	-0.44200	0.49197	-0.90	0.3741	<b>-0.11061</b>
X3	1	-13.47016	7.09966	-1.90	0.0647	<b>-0.23393</b>

5) The variance inflation factors are given below. Although no single value is particularly large (>10), the mean (1.881533) is below 2, so there is no cause concern.

Parameter Estimates

Variable	DF	Squared Semi-partial Corr Type I	Squared Partial Corr Type I	Squared Semi-partial Corr Type II	Squared Partial Corr Type II	Variance Inflation
Intercept	1	.	.	.	.	0
X1	1	0.61898	0.61898	0.21374	0.40211	<b>1.63230</b>
X2	1	0.03597	0.09441	0.00611	0.01886	<b>2.00324</b>
X3	1	0.02724	0.07894	0.02724	0.07894	<b>2.00906</b>