**ChE 320\_Spr\_17\_HW 11 Grading Rubric**

**Total: 100 pts, with 40 pts extra credit** (Please do not cut point more than once for the same mistake, e.g. If there are 3 parts in a question, answer was calculated wrong in the 1st part. But the method was correct for the 2nd and 3rd part; give student the points of 2nd and 3rd part*. If applicable, credits for the answersare also given for using correct units*)

**6-20 (60 pts)**

a) The results from Minitab follow.

**Regression Analysis: Density versus Cont, Loss**

The regression equation is

Density = - 0.110 + 0.407 Cont + 2.11 Loss

Predictor Coef SE Coef T P VIF

Constant -0.1105 0.2501 -0.44 0.670

Cont 0.4072 0.1682 2.42 0.042 390.1

Loss 2.108 5.834 0.36 0.727 390.1

S = 0.00883422 R-Sq = 99.7% R-Sq(adj) = 99.7%

Analysis of Variance

Source DF SS MS F P

Regression 2 0.23563 0.11782 1509.64 0.000

Residual Error 8 0.00062 0.00008

Total 10 0.23626

Source DF Seq SS

Cont 1 0.23562

Loss 1 0.00001

The regression equation iswhere 

+ 3 pts for correct answers

Density will increase if dielectic constant or loss factor increases. + 2 pts for reasonable answers

b) + 3 pts for reasonable answers

-0.0089354

-0.0090847

-0.0030180

0.0025153

0.0074740

0.0087559

0.0079298

0.0098885

0.0008422

-0.0051274

-0.0112404

c) SSE = 0.00062 + 3 points

= 0.00008 + 3 points

d) R-Sq = 99.7%, + 2 points

R-Sq(adj) = 99.7%. + 2 points

R-Sq(adj) is equal to R-Sq. + 2 points

e) Analysis of Variance

+ 4 points

Source DF SS MS F P

Regression 2 0.23563 0.11782 1509.64 0.000

Residual Error 8 0.00062 0.00008

Total 10 0.23626

Based on the P-value from the ANOVA table, the regression model is significant at the 0.05 level of significance.

+ 2 points

f) , + 2 points

, + 2 points

and  + 2 points

g) Predictor Coef SE Coef T P VIF

Constant -0.1105 0.2501 -0.44 **0.670**

Cont 0.4072 0.1682 2.42 **0.042** 390.1

Loss 2.108 5.834 0.36 **0.727** 390.1 + 2 pts for each p-value (+ 6 total)

Based on the P-values for each coefficient, only Cont is significantly different from zero at the 0.05 level of significance. + 3 points

h) β0: -0.1105 ± 2.306(0.2501); -0.6872, 0.4662 + 2 points

β1: 0.4072 ± 2.306 (0.1682); 0.01933, 0.7951 + 2 points

β2 : 2.108 ± 2.306 (5.834); -11.345, 15.561 + 2 points

The Cis agree with the t-test results presented in g). + 2 points

i)

SRES COOK

-1.23832 0.255007

-1.44997 0.692448

-0.37215 0.008618

0.32815 0.011784

0.92827 0.058551

1.08437 0.077203 + 4 points

1.02796 0.109710

1.35664 0.287682

0.11001 0.001337

-0.67570 0.054084

-1.59530 0.485253

The model is accurate. + 2 points







j) The VIFs are 390.1. + 2 points

There is an indication of a problem with multicollinearity. + 3 points

**6-30 (20 pts)**

The regression equation is

y = - 171 + 7.03 x1 + 12.7 x2

Predictor Coef SE Coef T P

Constant -171.26 28.40 -6.03 0.001

x1 7.029 1.539 4.57 0.004

x2 12.696 1.539 8.25 0.000

S = 3.07827 R-Sq = 93.7% R-Sq(adj) = 91.6%

Analysis of Variance

Source DF SS MS F P

Regression 2 842.37 421.18 44.45 0.000

Residual Error 6 56.85 9.48

Total 8 899.22

a)  + 4 points

b)  + 1 point

, + 1 point

, + 1 point

 + 1 point

c) Predictor Coef SE Coef T P

Constant -171.26 28.40 -6.03 0.001

x1 7.029 1.539 4.57 0.004 + 2 for correct p-values

x2 12.696 1.539 8.25 0.000

Based on the P-values from the t-test for each coefficient, both regressors appear to be significant at the 0.05 level of significance. + 2 points for reasonable answer

d)  + 1 point



 + 1 point

e)  + 1 point



 + 1 point

f) The prediction interval is wider than the confidence interval because it predicts a range for a **future observation** whereas the confidence interval predicts a range for the **mean response.**

+ 4 points for reasonable answer

**\*6-33 (20 pts extra credit)**

a) The regression equation is

y = 643 + 11.4 x1 - 0.933 x2 - 0.0106 x1x2 - 0.0272 x1^2 +0.000471 x2^2

+ 8 points

Predictor Coef StDev T P VIF

Constant 642.685 0.000 \* \*

x1 11.3862 0.0000 \* \* 2675.3

x2 -0.933346 0.000000 \* \* 1283.4

x1x2 -0.0106334 0.0000000 \* \* 8342.1

x1^2 -0.0271620 0.0000000 \* \* 502.4

x2^2 0.00047076 0.00000000 \* \* 3301.5

S = \*

Analysis of Variance

Source DF SS MS F P

Regression 5 14112.00 2822.40 \* \*

Residual Error 0 \* \*

Total 5 14112.00

Source DF Seq SS

x1 1 10240.37

x2 1 1921.21

x1x2 1 827.86

x1^2 1 1056.39

x2^2 1 66.17

b) Because VIF’s are much greater than 10, multicollinearity is present in the second-order model.

+ 6 points for reasonable answer

c) Because SSE(Full Model) is not available the test statistic cannot be computed. + 6 points for reasonable answer

**6-35 (20 pts)**

a) All possible regressions.

Response is Sat + 5 points for reasonable answer

S

A S u A

Mallows g e r n

Vars R-Sq R-Sq(adj) C-p S e v g x

1 82.1 80.8 4.4 9.3577 X

1 57.0 54.0 27.3 14.487 X

2 87.9 86.1 1.1 7.9723 X X

2 83.0 80.4 5.5 9.4476 X X

3 88.0 85.0 3.0 8.2768 X X X

3 87.9 84.9 3.0 8.2942 X X X

4 88.0 83.6 5.0 8.6446 X X X X

b) Forward selection. Alpha-to-Enter: 0.25 + 5 points for reasonable answer

Response is Sat on 4 predictors, with N = 16

Step 1 2

Constant 136.2 146.7

Age -1.43 -1.12

T-Value -8.01 -5.76

P-Value 0.000 0.000

Sev -0.56

T-Value -2.51

P-Value 0.026

S 9.36 7.97

R-Sq 82.07 87.92

R-Sq(adj) 80.79 86.06

Mallows C-p 4.4 1.1

c) Backward elimination. Alpha-to-Remove: 0.1 + 5 points for reasonable answer

Response is Sat on 4 predictors, with N = 16

Step 1 2 3

Constant 146.2 146.2 146.7

Age -1.12 -1.12 -1.12

T-Value -5.25 -5.51 -5.76

P-Value 0.000 0.000 0.000

Sev -0.59 -0.59 -0.56

T-Value -2.11 -2.22 -2.51

P-Value 0.058 0.046 0.026

Surg 0.1

T-Value 0.03

P-Value 0.979

Anx 0.5 0.6

T-Value 0.22 0.25

P-Value 0.832 0.809

S 8.64 8.28 7.97

R-Sq 87.98 87.98 87.92

R-Sq(adj) 83.61 84.97 86.06

Mallows C-p 5.0 3.0 1.1

d) Model with only *age* and *severity* seems to be the “best” among all. It has a large R-Sq(adj) and small Cp and values.

+ 5 points for reasonable answer

**\*6-46 (20 pts extra credit)**

a) The regression equation is

y = 3829 - 0.215 x3 + 21.2 x4 + 1.66 x5 + 3 points

Predictor Coef SE Coef T P

Constant 3829 2262 1.69 0.099

x3 -0.2149 0.1088 -1.97 0.056

x4 21.2134 0.9050 23.44 0.000

x5 1.6566 0.5502 3.01 0.005

S = 43.66 R-Sq = 99.3% R-Sq(adj) = 99.3%



b) Analysis of Variance

Source DF SS MS F P

Regression 3 9863398 3287799 1724.42 0.000

Residual Error 36 68638 1907

Total 39 9932036

The P-value from the ANOVA table is approximately zero. Therefore, reject H0 and conclude that the regression model is significant at α = 0.01. The test can also be conducted in more detail as follows:



for at least one j + 2 points for reasonable answer

The test statistic is



Reject H0 if f0 > fα,3,36 where f0.01,3,36 = 4.38

Using the results from the ANOVA table



Because 1724.42 > 4.38 reject H0 and conclude that the regression model is significant at α = 0.01. The P-value < 0.00001

+ 2 points for reasonable answer

c) All at α = 0.01 t0.005,36 = 2.72

  

  

t0 = -1.97 t0 =23.44 t0 = 3.01

  

Fail to reject  Reject  Reject 

Potentially the x3 term can be removed from the model. + 2 points for reasonable answer

d) R2 = 0.993 + 1 point  + 1 point

The slight decrease in may be reflective of the insignificant x3 term. + 1 point

e)



The normality assumption appears reasonable. The residuals fall along a line. + 2 points for reasonable answer

f)



The plot is satisfactory. There does not appear to be a nonrandom pattern in the residual vs. predicted plot.

+ 2 points for reasonable answer

g)



There is a slight indication that variance increases as **x3** increases. There is a “fanning out” appearance of the residuals.

. + 2 points for reasonable answer

h) Using the equation found in part a):

 . + 2 points for reasonable answer