**ChE 320\_Spr\_17\_HW 12 Solution**

**Total: 100 pts.**(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 answers are also given for using correct units*)

**7-2 (50 pts)**

a) Predictor Coef StDev T P

Constant 73.750 3.955 18.65 0.000

Paint -0.083 3.955 -0.02 0.984

Time 1.417 3.955 0.36 0.729

Paint\*Ti -9.750 3.955 -2.47 0.039

*+ 8 for correct answers (estimate effects, standard errors) (+4 for partially correct answers)*

b)

*+ 5 for correct figure*

The interaction plot indicates an interaction between drying time and paint type. *+ 5 for reasonable comment*

c) The t-ratios are given in the output shown in part a. The t-ratios indicate that the interaction of Paint type\*Drying Time is significant at the α = 0.05 level. *+8 for correct comment*

d) The approximate 95% confidence intervals are given by effect estimate ± 2s.e.(effect) where effect = 2(coefficient). The coefficient and the s.e.(coefficient) are given in the Minitab output of part a). s.e.(effect) = 2[s.e.(coefficient)].

Paint Type: effect = 2(coefficient) = 2(-0.083) = -0.167, s.e.(effect) = 2(3.955) = 7.91

Approximate 95% confidence interval on the the effect of Paint Type: −0.167 ± 2(7.91), (−15.987, 15.653)

*+3 for correct comment*

Drying Time: effect = 2(coefficient) = 2(1.417) = 2.834, s.e.(effect) = 2(3.955) = 7.91

Approximate 95% confidence interval for the effect of Drying Time: 2.834 ± 2(7.91), (−12.986, 18.654)

*+3 for correct comment*

Paint Type\*Drying Time: effect = 2(coefficient) = 2(-9.750) = -19.50, s.e.(effect) = 2(3.955) = 7.91

Approximate 95% confidence interval for the effect of Paint Type\*Drying Time: −19.50 ± 2(7.91), (−35.32, −3.68) *+3 for correct comment*

e) The regression analysis and, in this case, the final model are

Surface Finish = 73.8 - 0.08 Paint Type + 1.42 Drying Time - 9.75 Paint Type\*Drying Time *+5 for correct regression model*

Predictor Coef StDev T P

Constant 73.750 3.955 18.65 0.000

Paint Ty -0.083 3.955 -0.02 0.984

Drying T 1.417 3.955 0.36 0.729

Paint\*Drying -9.750 3.955 -2.47 0.039

S = 13.70 R-Sq = 43.7% R-Sq(adj) = 22.6%

*+5 for correct analysis of hypothesis tests*

Based on the regression analysis, only the interaction appears to be significant. Since we have adopted the procedure of using hierarchical models, then this result is equivalent to that obtained in part c).

Analysis of Variance

Source DF SS MS F P

Regression 3 1164.9 388.3 2.07 0.183

Error 8 1501.3 187.7

Total 11 2666.2

Source DF Seq SS

Paint Ty 1 0.1

Drying T 1 24.1

Paint Ty 1 1140.7

The analysis of variance indicates the final regression model is inadequate for this set of data (P-value=0.183).









There does not appear to be any serious departure from normality shown in the normal probability plot of the residuals. The assumption of constant variance does not appear to be seriously violated. The residuals for the high level of the interaction appear to be slightly more disperse than those for the low level.

*+ 5 for reasonable conclusion*

**7-10 (30 pts)**

a) Source DF SS MS F P

Regression 3 3.3095 1.1032 183.86 0.000

Residual Error 16 0.0960 0.0060

Total 19 3.4055 *+ 2 for each value (+6 total)*





b) Because the P-value is less than α = 0.05, the model is significant. *+ 5 for correct answer*

c) *+ 3 for correct method, +2 for correct answer*

d) Predictor Coef SE Coef T P

Constant 10.3650 0.01732 598.42 0.000

x1 0.40500 0.01732 23.38 0.000

x2 0.01500 0.01732 0.87 0.399

x1\*x2 0.03500 0.01732 2.02 0.060 *+ 2 for each value (+6 total)*

The P-value of x1 = 0.000 is less than α = 0.05, so x1 is significant. The P-values of x2 and x1x2 are 0.399 and 0.060, respectively, which are not smaller than α = 0.05, so they are not significant, but the x1x2 interaction is marginal.





P-valuex1 = 2P(t > |0.87|) and for degrees of freedom of 16 we obtain 2 (0.1)<P-value < 2(0.25) = 0.2 < P-value < 0.5

e)  *+ 4 for correct answer*

f)  *+ 4 for correct answer*

**7-11 (20 pts)**

a) SS(Main Effect) = SSA + SSB = 7.84083 + 0.80083 = 8.64166 *+ 2 for correct method, +2 for correct answer*

*+ 2 for correct method, +2 for correct answer*

 *+ 2 for correct method, +2 for correct answer*

b) When we conduct a lack of fit test for the interaction term AB, we obtain the sum of squares for the lack of fit by using the sum of squares of the interaction term AB.

SS(residual) = SST - SSA- SSB = 9.9625 - 7.84083 - 0.80083 = 1.32084

Df(residual) = 11 - 1- 1 = 9

SS(Lack of fit) = SSAB = 1.14083 and df(Lack of fit) = 1

SS(Pure Error) = SS(residual) - SS(Lack of fit) = 1.32084 -1.14083 = 0.18001

Df(Pure Error) = df(residual) - df(Lack of fit) = 9 - 1 = 8







P-value is > 0.25, so there is not strong evidence of lack of fit. We would pool the lack of fit and pure error sum of squares to estimate the variance. *+ 4 for correct lack-of-fit test method, +4 for reasonable conclusion*