Name _____ /120

Both problems are worth 60 points.

1. Liquid ethanol has approximately 65% of the energy density of petroleum based gasoline. Thus, it is to be expected that "E blend" vehicle fuels will have lower fuel efficiency than regular gasoline. However, in practice fuel efficiency is a complicated function of many other factors besides fuel energy content. To investigate the effects of different ethanol concentrations on fuel efficiency, six different cars of the same make and model, each a 2007 Toyota Camry, were driven at a nearly steady speed of 65 mph over the same 200 mile stretch of interstate highway. This trip was repeated four times for each car using a different ethanol mixture which was randomly assigned to a given car on a given trip. The fuels were E-00, regular gasoline, E-10, 10% ethanol, E-20, 20% ethanol, and E-40, 40% ethanol. The fuel efficiency results are stated below in units of mpg (miles per gallon).

E - 00	E - 10	E - 20	E- 40
33.00	**32.76**	**31.23**	**31.99**
34.96	**32.73**	**33.26**	**31.49**
34.38	**35.29**	**33.62**	**31.47**
34.06	**31.53**	**32.33**	**32.17**
34.66	**33.50**	**33.17**	**30.53**
33.75	**33.93**	**33.07**	**31.98**

Test at a 5% level of significance whether there are any differences in fuel efficiency associated with the different ethanol blends. State and explain your conclusion. Explain how you reached your conclusion. Compute and report the *P*- Value of your observed statistic.

Now determine by a Bonferroni procedure which, if any, of the four fuels are significantly different from each other in their mean fuel efficiency.

What assumptions are necessary for the above Single Factor ANOVA to be valid?

Do these assumptions seem to be satisfied by this particular set of data? Explain your answer.

Hand in a spreadsheet with the exam.

2. The data shown below gives the measured NO_X emission concentrations (in ppm) for 12 pairs of power boilers. The boilers in each pair have a pre-determined burner area liberation rate (in MBTU/ft^2 per hour). Assume the determination of burner area liberation rate is not subject to any error.

Burner Rate	NO_X Concentration
100	93
100	116
125	158
125	165
150	202
150	203
200	267
200	305
250	365
250	402
300	477
300	483
350	584
350	605
400	653
400	659
450	728
450	762
500	829
500	808
550	910
550	930
600	1037
600	1029

In Excel perform a regression analysis on this data. Your spreadsheet analysis of this data set should contain two scatter plots. The **first** should display **both the data and the predictions of the linear regression model** drawn as a continuous line. The **second** should display the **residuals** plotted versus the control variable.

Assuming that the underlying relation between burner area liberation rate and NO_X concentration is linear and that the errors in the measurements are normally distributed, calculate the lower and upper limits for a 99% confidence intervals requested in the following table.

99% Confidence Interval	Lower Limit	Upper Limit
Population Slope β_1		
Population Intercept β_0		
The actual NO_x Concentration when the Burner Rate = 325		
A measurement of NO_x Concentration when the Burner Rate = 325		
The actual NO_x Concentration when the Burner Rate = 625		
A measurement of NO_x Concentration when the Burner Rate = 625		

For what value of Burner Rate does the confidence interval for the NO_x Concentration have the smallest width. Explain why this is true.

Fill in the following Regression ANOVA table as shown below.

Source	Sum of Squares	Degrees of Freedom	Mean Square
Linear Model			
Error			
Total			

Observed *F* score _____

At a 1% level of significance, what conclusion do you draw from this ANOVA Table?

Compute both the correlation coefficient and the coefficient of determination.

Comment on how well the linear model fits this data.

What does the pattern of residuals indicate about the adequacy of the linear model?