

Question 1. (35 points)

Use the etch rate data on lecture slide to answer this question.

- (a) Fit the three types of models on the lecture notes. Write down the three models.
- (b) What is your prediction of etch rate when RF Power=200 based on each of the model you obtained in (a)? Are the predictions the same from the three models.
- (c) Are the etch rates significantly different with RF Power=160 and 180?
- (d) Which RF Power provides the largest etch rate?

Question 2. (15 points)

3.7 A computer ANOVA output is shown below. Fill in the blanks.

One-way ANOVA					
Source	DF	SS	MS	F	P
Factor	?	?	246.93	?	?
Error	25	186.53	?		
Total	29	1174.24			

Question 3. (30 points)

3.9 The tensile strength of Portland cement is being studied. Four different mixing techniques can be used economically. A completely randomized experiment was conducted and the following data were collected:

Mixing Technique	Tensile Strength (lb/in <sup>2</sup> )			
1	3129	3000	2865	2890
2	3200	3300	2975	3150
3	2800	2900	2985	3050
4	2600	2700	2600	2765

- a. Test the hypothesis that mixing techniques affect the strength of the cement. Use  $\alpha = 0.05$ .

Use the derivation of ANOVA table on lecture notes, reproduce the ANOVA table by hand (or with your own code): compute the group means, grand mean, sum of squares, df, MS, and F, and verify they match your software output (R/Python/Matlab).

- d. Construct a normal probability plot of the residuals. What conclusion would you draw about the validity of the normality assumption?  
e. Plot the residuals versus the predicted tensile strength. Comment on the plot.

Question 4. (20 points)

3.12 A product developer is investigating the tensile strength of a new synthetic fiber that will be used to make cloth for men's shirts. Strength is usually affected by the percentage of cotton used in the blend of materials for the fiber. The engineer conducts a completely randomized experiment with five levels of cotton content and replicates the experiment five times. The data are shown in the following table.

Cotton Weight Percent	Observations				
15	7	7	15	11	9
20	12	17	12	18	18
25	14	19	19	18	18
30	19	25	22	19	23
35	7	10	11	15	11

- a. Is there evidence to support the claim that cotton content affects the mean tensile strength? Use  $\alpha = 0.05$ .  
c. Analyze the residuals from this experiment and comment on model adequacy.