

Minor Exam

MAL2040: Design and Analysis of Experiments

Date: 2026-02-21

Duration: 120 minutes

Total: 25 points

Name: _____

Roll No.: _____

Instructions:

- Hand calculators are allowed.
- State all assumptions used for full credit.
- Unnecessary explanations can result in loss of credit.

Problem 1. **[1 point]**

Computer output for a random sample of data is shown below. Some of the quantities are missing. Compute the missing entries in the table.

Variable	N	Mean	Std. Dev.	Variance	Minimum	Maximum	Sum
Y	8	21.67	3.43	?	16.84	29.13	?

Problem 2. **[2 points]**

Write down the fixed-effects one-way ANOVA model, and clearly state all the assumptions of the model.

Problem 3. **[2 points]**

Write down the fundamental ANOVA identity, and interpret each of the terms in one sentence each.

Problem 4. **[3 points]**

Suppose that we are testing

$$H_0 : \mu_1 = \mu_2 \quad \text{versus} \quad H_1 : \mu_1 \neq \mu_2,$$

where the two sample sizes are $n_1 = n_2 = 10$. The population variances are unknown but assumed to be equal.

- (a) Is the alternative hypothesis one-sided or two-sided?
- (b) Find bounds on the p-value for the test statistic $F_0 = 2.80$ for the one-way ANOVA.
- (c) Will you accept or reject the null hypothesis at the significance level $\alpha = 1\%$?

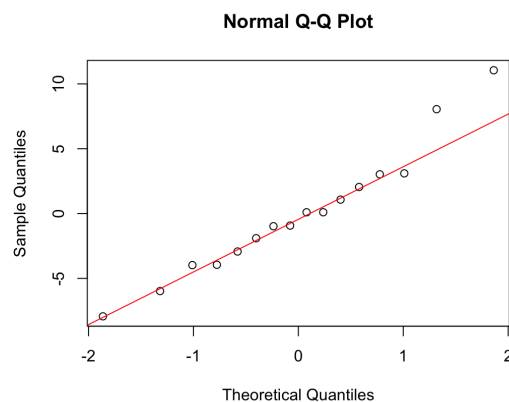
Problem 5. **[3 points]**

Partial computer output for one-way ANOVA is shown below. Fill in the blanks.

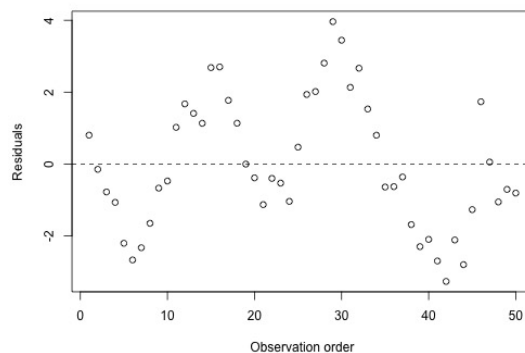
Source	DF	SS	MS	F	P
Factor	3	36.15	?	?	?
Error	?	?	?		
Total	19	196.04			

Problem 6.**[2 points]**

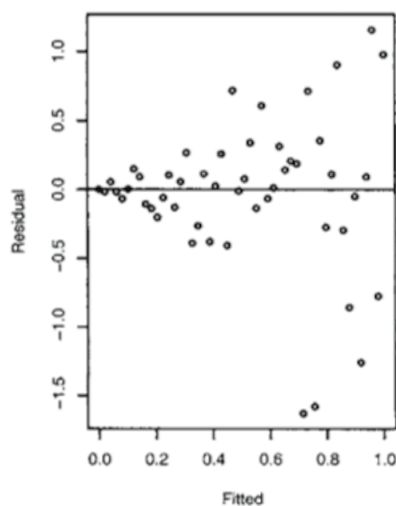
The figure below shows a normal probability plot of the residuals obtained from a dataset. What conclusions can you draw from this plot?

**Problem 7.****[2 points]**

The figure below shows a plot of residuals versus observation order. What conclusions can you draw from this plot?

**Problem 8.****[2 points]**

The figure below is an example of a plot of residuals versus fitted values. What conclusions can you draw from this plot?



Problem 9.**[5 points]**

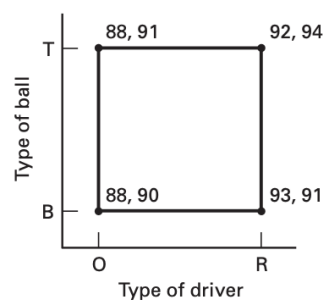
The tensile strength of Portland cement is being studied. Four different mixing techniques can be used economically. A completely randomized experiment was conducted and data was collected, shown below after coding:

Mixing Technique	Tensile Strength			
1	3	1	10	6
2	12	9	-3	3
3	-6	-4	-8	-13
4	-11	-13	-8	-11

Use standardized residuals to detect any outliers in this data.

Problem 10.**[3 points]**

A 2^2 factorial experiment is conducted, in which I calculate my golf scores based on two factors: the type of driver—oversized (O) or regular sized (R)—and the type of golf ball—balata (B) or three piece (T). The figure below shows the data from the experiment: I conducted two runs of the experiment at each combination of the factor levels.



Compute the driver effect, the ball effect, and the ball–driver interaction effect.

End of Quiz