Quiz 1-A

MAL2040: Design and Analysis of Experiments Date: 2026-01-28

Duration: 40 minutes Total: 10 points

Name: _____ **Roll No.:** _____

Instructions:

- State all assumptions used for full credit.
- Hand calculators are allowed.

Problem 1. **[2 points]**

Recall that $\mathrm{Cov}[Y_1, Y_2] := \mathbb{E}[(Y_1 - \mathbb{E}[Y_1])(Y_2 - \mathbb{E}[Y_2])]$.
Show, using this formula or otherwise, that $\mathrm{Cov}[Y_1, Y_2] = \mathbb{E}[Y_1 Y_2] - \mathbb{E}[Y_1]\mathbb{E}[Y_2]$.

Problem 2.

(a) Write down the equations and assumptions of the fixed effects model for one-way ANOVA. **[1 point]**

(b) Show that in the fixed effects model $\hat{\mu} := \overline{Y}_{\cdot\cdot}$ is an unbiased estimator of the grand mean μ. **[2 points]**

Problem 3. **[5 points]**

In semiconductor manufacturing wet chemical etching is often used to remove silicon from the backs of wafers prior to metalization. The etch rate is an important characteristic of this process. Two different etching solutions are being evaluated. Eight randomly selected wafers have been etched in each solution, and the (coded) observed etch rates (in mils/min) are as follows.

Solution 1		**Solution 2**	
-1	6	2	6
-6	3	0	2
0	-7	7	4
3	-2	5	3

Does the data support the claim that both solutions have the same mean etch rate? Fill in the ANOVA table and make your conclusion at the significance level $\alpha = 0.05$.

ANOVA Table:

Source of Variation	**Sum of Squares**	**Degrees of Freedom**	**Mean Square**	F_0	**p-value**
Treatments					
Error					
Total					

Decision (at $\alpha = 0.05$): _____

End of Quiz