DATE: 2023-09-10

LAB 9: Completely Randomized Design (CRD)

Four different designs for a digital computer circuit are being studied to compare the amount of noise present. The following data have been obtained:

Circuit Design	Noise Observed				
1	19	20	19	30	08
2	80	61	73	56	80
3	45	26	25	35	50
4	95	46	83	78	97

(a) Carryout one-way ANOVA to determine whether same amount of noise present for all four designs? Use α =0.05

(b) Which circuit design would you select for use? Low noise is best.

One-way ANOVA: Noise Level versus Circuit Design

Method

Null hypothesis	All means are equal
Alternative hypothesis	Not all means are equal
Significance level	α = 0.05

Equal variances were assumed for the analysis.

Factor Information

Factor	Levels	Values
Circuit Design	4	1, 2, 3, 4

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Circuit Design	3	12102	4033.9	22.18	0.000
Error	16	2910	181.9		
Total	19	15012			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
13.4870	80.61%	76.98%	69.71%

Means

Circuit Design	N	Mean	StDev	95% CI
1	5	19.20	7.79	(6.41, 31.99)
2	5	70.00	11.02	(57.21, 82.79)

3	5	36.20	11.17	(23.41, 48.99)
4	5	79.80	20.51	(67.01, 92.59)

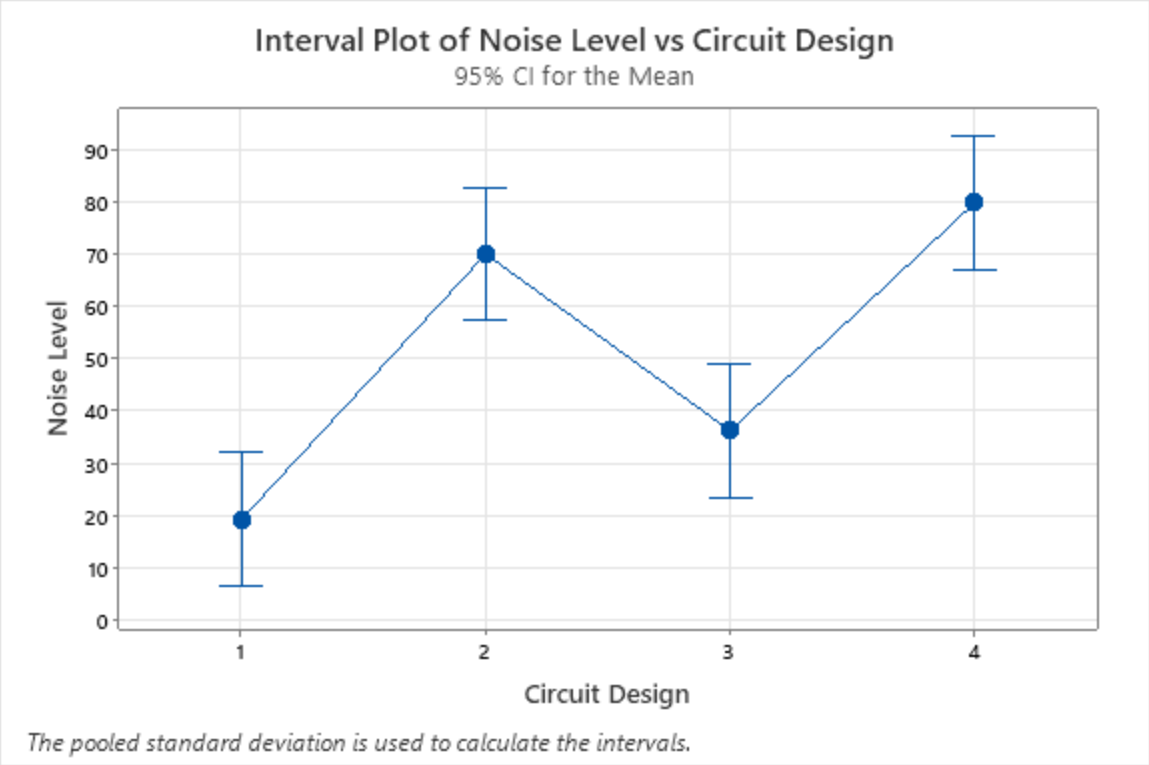
Pooled StDev = 13.4870

Tukey Pairwise Comparisons

Grouping Information Using the Tukey Method and 95% Confidence

Circuit Design	N	Mean	Grouping	
4	5	79.80	A	
2	5	70.00	A	
3	5	36.20		B
1	5	19.20		B

Means that do not share a letter are significantly different.



WORKSHEET 1

General Linear Model: Tensile Strength versus Chemical Agents, Bolt Type

Method

Factor coding (-1, 0, +1)

Factor Information

Factor	Type	Levels	Values
Chemical Agents	Fixed	4	1, 2, 3, 4
Bolt Type	Fixed	5	1, 2, 3, 4, 5

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Chemical Agents	3	25.20	8.400	4.33	0.028
Bolt Type	4	179.50	44.875	23.11	0.000
Error	12	23.30	1.942		
Total	19	228.00			

Model Summary

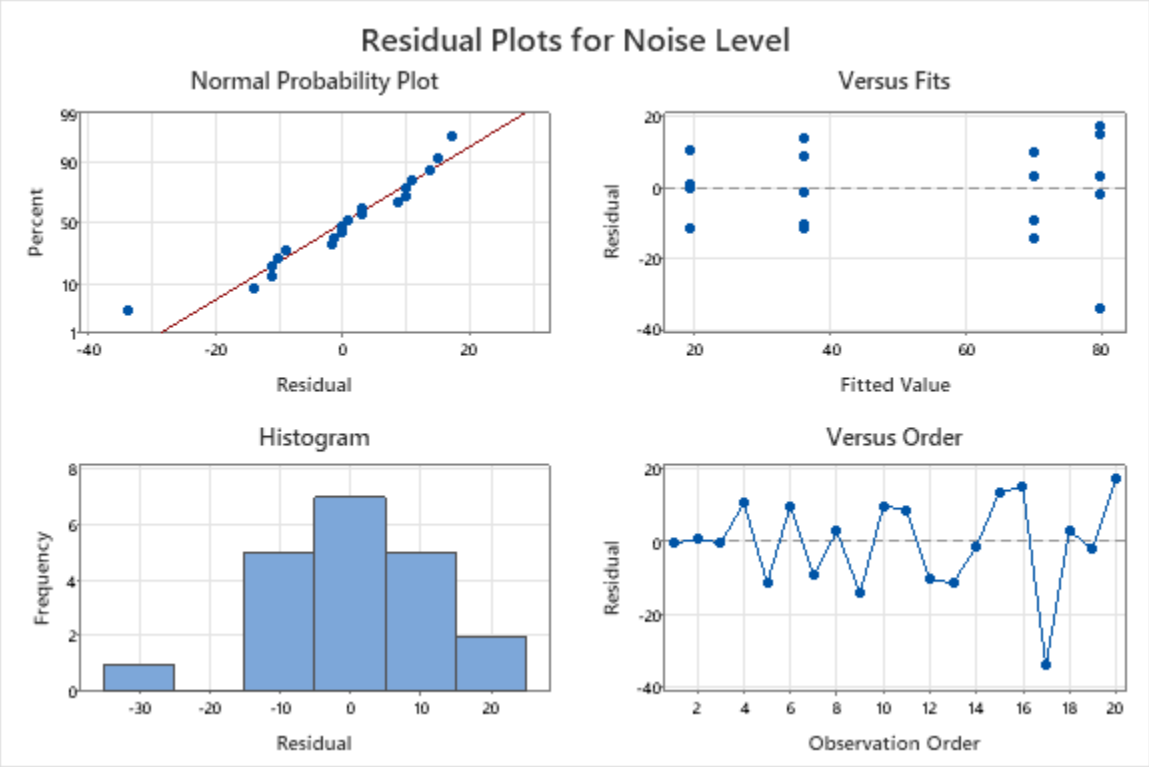
S	R-sq	R-sq(adj)	R-sq(pred)
1.39344	89.78%	83.82%	71.61%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	72.000	0.312	231.08	0.000	
Chemical Agents					
1	-1.400	0.540	-2.59	0.023	1.50
2	-0.600	0.540	-1.11	0.288	1.50
3	0.400	0.540	0.74	0.473	1.50
Bolt Type					
1	2.750	0.623	4.41	0.001	1.60
2	-3.500	0.623	-5.62	0.000	1.60
3	3.500	0.623	5.62	0.000	1.60
4	0.750	0.623	1.20	0.252	1.60

Regression Equation

Tensile Strength = 72.000 - 1.400 Chemical Agents_1 - 0.600 Chemical Agents_2
+ 0.400 Chemical Agents_3 + 1.600 Chemical Agents_4 + 2.750 Bolt Type_1
- 3.500 Bolt Type_2 + 3.500 Bolt Type_3 + 0.750 Bolt Type_4
- 3.500 Bolt Type_5



CONCLUSION

1. Since p-value = 0.000 < α = 0.05, we reject the null hypothesis at 5% level of significance. It means that noise level is not same for four digital circuit type.
2. Model summary shows that the R^2 = 80.61%, which means that linear model is good fit.
3. Lowest mean noise level is of circuit type 1 (19.20) and highest mean noise level is of circuit type 4 (79.80).
4. Tukey's comparison shows that there are two cluster groups, first comprising of circuit type 3 and 1, producing lowest noise levels and second comprising of circuit type 4 and 2, producing highest noise levels. It means that there is no significant difference between circuit type 3 and 1 in regard to noise level produced by them. In second group, there is no significant difference between circuit type 4 and 2.
5. Error distribution is not normal, rather it is left skewed as shown by the graph.
6. Homogeneity of variance is not met well.
7. Random pattern of errors in graph of error vs observation order, shows that errors are not related.