ME 794 Statistical Design of Experiments

Single Factor ANOVA and Randomised Block Design

Assignment 4

Due: March 19, 2023

1. Product developer is investigating the tensile strength of a new synthetic fibre 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: **[5+2 marks]**

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

Write a script in python to solve the following by considering the above table as input data and the following ANOVA table as output format.

a. Is there evidence to support the claim that cotton content affects the mean tensile strength? Use $\alpha = 0.05$ (*Hint:* Complete the ANOVA table and then comment).

b. Analyze the residuals from this experiment and comment on model adequacy. (The plot must have the x-axis as Residuals and the y-axis as Normal Score, in BLUE colour).

Source of variation	**Sum of Squares**	**Degrees of Freedom**	**Mean Square**	**F_o**
Between Treatments				
Error (Within treatments)				
Total				

2. An article in the Fire Safety Journal ("The Effect of Nozzle Design on the Stability and Performance of Turbulent Water Jets," Vol. 4, August 1981) describes an experiment in which a shape factor was determined for several different nozzle designs at six levels of jet efflux velocity. Interest focused on potential differences between nozzle designs, with velocity considered as a nuisance variable. The data are shown below: **[6+2marks]**

Nozzle Design	Jet Efflux Velocity (m/s)					
	11.73	*14.37*	*16.59*	*20.43*	*23.46*	*28.74*
1	0.78	0.80	0.81	0.75	0.77	0.78
2	0.85	0.85	0.92	0.86	0.81	0.83
3	0.93	0.92	0.95	0.89	0.89	0.83
4	1.14	0.97	0.98	0.88	0.86	0.83
5	0.97	0.86	0.78	0.76	0.76	0.75

Write a script in python to solve the following by considering the above table as input data and the following ANOVA table as output format.

a. Does nozzle design affect the shape factor at $\alpha = 0.05$? (*Hint:* Complete the ANOVA table and then comment)

b. Analyze the residuals from this experiment.
(Plot the "Residual variable" on the x-axis and the "Normal % probability" variable on the y-axis).

Source of variation	Sum of Squares	Degrees of Freedom	Mean Square	F_o
Treatments				
Blocks				
Error				
Total				

For all cases,

- Provide a generic code that can allow users to input the size and values of matrices according to their preferences.
- All plots must have x-and y-axis labels.
- Line thickness should be two wherever applicable.
- Include the script file and results in a single pdf file to receive full credit.
- Separate Jupyter notebook (.ipynb format) for each question (two in this case).