Reg No.:_____   Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Second Semester M.Tech Degree (FT and PT) Regular Examination June 2023

Discipline: MECHANICAL ENGINEERING

Course Code & Name: 222TME100 DESIGN OF EXPERIMENTS

Max. Marks: 60   Duration: 2.5 Hours

(Use of statistical data books or attested statistical tables & formulae are permitted)

PART A
Answer all questions. Each question carries 5 marks   Marks

1	What are the advantages and limitations of Pareto analysis?	(5)
2	Explain the two types of errors in Hypothesis testing.	(5)
3	Distinguish between Randomization and Replication techniques used in experimental design.	(5)
4	Describe the concept of confounding in factorial design experiment.	(5)
5	Explain central composite design and its advantages.	(5)

PART B
Answer any 5 questions. Each question carries 7 marks

6   For an electronic device manufacturer, the charge cycles of a particular (7) lithium-ion battery is of interest. Ten batteries are randomly selected and tested, and the following results are obtained

316	376
348	426
348	418
312	364
330	378

(a) Demonstrate that the mean charge cycle exceeds 320 cycles. Setup an approximate hypothesis for investigating this claim.

(b) Test these hypothesis using $\alpha = 0.01$. What are your conclusions?

7   An engineer is testing the effect of duration of a heat treatment method on the (7) thermal conductivity of a material. The engineer conducts a completely randomized experiment with five levels of treatment duration and replicates the experiment five times. The observed data are shown in the table.

Duration (hrs)	Thermal conductivity of the material (W/m-K)				
20	112	112	111	110	111
25	113	111	112	111	110
30	111	112	111	112	112
35	110	111	112	110	113
40	113	110	112	111	111

Formulate a suitable hypothesis to test if there is evidence to support the claim that duration of heat treatment affects the mean thermal conductivity. Use level of significance $\alpha = 0.05$

8. The effect of four different lubricating oil samples on fuel economy in diesel truck engines is being studied. Fuel economy is measured using brake-specific fuel consumption after the engine has been running for 15 minutes. Four different truck engines are available for the study, and the experimenters conduct the following RCBD experiments. The experimental data are shown in the table below. (7)

Oil sample	Truck			
	A	B	C	D
1	0.518	0.675	0.488	0.522
2	0.514	0.666	0.482	0.541
3	0.512	0.671	0.487	0.515
4	0.516	0.669	0.488	0.514

Analyze the data from this experiment and test whether the type of oil used has an effect on fuel economy of the engine.

9. The effect of order of four different tools (A, B, C, D) used on the time for completion of a particular fabrication process is being investigated. Four different operators are selected for the study. As the fabrication progresses, the work piece gets heated up and slows down the process regardless of the tool used. A Latin Square design used to account for this slowing down due to overheating is shown below. (7)

Order of Tool used	Operator			
	1	2	3	4
1	C = 4	D = 6	A = 4	B = 4
2	B = 3	C = 8	D = 6	A = 4
3	A = 2	B = 5	C = 5	D = 5
4	D = 6	A = 5	B = 6	C = 7

Analyze the data from the experiment with α =0.05 and draw appropriate conclusions.

10 The yield of a chemical process is being studied. The two most important variables are thought to be the pressure and the temperature. Three levels of each factor are selected, and a factorial experiment with two replicates is performed. **(7)**

Temperature	Pressure (bar)		
(°C)	100	150	200
200	80.5	80.5	80.1
	80.2	80.6	80.3
250	80.6	80.4	80.4
	80.4	80.7	80.6
300	80.7	80.3	80.5
	80.1	80.2	80.2

Analyze the yield data shown above and draw appropriate conclusions using α =0.05

11 A mechanical engineer is studying the thrust force developed by a drill press. He suspects that the drilling speed and the feed rate of the material are the most important factors. He selects four feed rates and uses a high and low drill speed chosen to represent the extreme operating conditions. He obtains the following results. **(7)**

Drill speed	Feed rate			
	0.02	0.025	0.03	0.035
250	2.6	2.8	2.9	2.7
	2.8	2.5	2.7	2.6
300	2.9	2.8	2.9	2.5
	2.5	2.6	2.4	2.5

Analyze the data and draw appropriate conclusions using α =0.05.

12 Construct a 2^{5-1} design. Show how the design may be run in two blocks of eight observations each. Are any main effects or two-factor interactions confounded with blocks? **(7)**

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