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NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA
(An Autonomous Institute Affiliated to AKTU, Lucknow)

MASTER OF TECHNOLOGY (M. Tech)

SEM: First Theory Examination (2020-2021)

SUBJECT NAME: DESIGN OF EXPERIMENTS

Time: 3 Hours

Max. Marks: 70

General Instructions:

- All questions are compulsory. Answers should be brief and to the point.
- This Question paper consists of04.....pages & ...8.....questions.
- It comprises of three Sections, A, B, and C. You are to attempt all the sections.
- Assume suitable data, if missing. Use of Statistical tables and calculator is permitted.
- **Section A** - Question No- 1 is objective type questions carrying 1 mark each, Question No- 2 is very short answer type carrying 2 marks each. You are expected to answer them as directed.
- **Section B** - Question No-3 is Long answer type -I questions with external choice carrying 4 marks each. You need to attempt any five out of seven questions given.
- **Section C** - Question No. 4-8 are Long answer type -II (within unit choice) questions carrying 7 marks each. You need to attempt any one part a or b.
- Students are instructed to cross the blank sheets before handing over the answer sheet to the invigilator.
- No sheet should be left blank. Any written material after a blank sheet will not be evaluated/checked.

SECTION – A

1. Answer all the parts-

[5x1=5]

CO

- | | | |
|--|-------------------|-------------------|
| <p>a. There are 30 students in each experimental condition in a 5x4 between-groups design, how many participants would be needed in total?</p> <p>a) 600
b) 20
c) 400
d) 30</p> | <p>(1)</p> | <p>CO1</p> |
| <p>b. ANOVA is a statistical method of comparing the _____ of several populations</p> <p>a) Variance
b) Standard deviations
c) Means
d) All of the above</p> | <p>(1)</p> | <p>CO2</p> |
| <p>c. What statistical procedure is used to assess the statistical significance of the main effects and the interaction(s) in a factorial design?</p> <p>a) Analysis of covariance
b) Correlation
c) T-test
d) Analysis of variance</p> | <p>(1)</p> | <p>CO3</p> |

- d. Factors in a factorial design are the_____. (1) CO4
 a) The experimental variables
 b) The independent variables
 c) The dependent variables
 d) The organismic variables
- e. Which of the following terms best describe an interaction effect? (1) CO1
 a) Eliminating any differential influence of extraneous variables
 b) The effect of one independent variable depends on the level of another independent variable
 c) The effect of one independent variable on the dependent variable
 d) Sequencing effect that occurs from the order in which the treatment conditions are administered

2. Answer all the parts- [5×2=10] CO
 a. What does the orthogonal array represents? (2) CO1
 b. What do you mean by attributed data? (2) CO2
 c. When do we use ANOVA? (2) CO3
 d. Write short note on S/N Ratios. (2) CO4
 e. Define the terms: noise factor and standard deviation. (2) CO4
 f.

SECTION – B

3. Answer any five of the following- [5×4=20] CO
 a. Explain any two factorial designs with the help of suitable example. (4) CO1
 b. How will you design and analyse a multi-factor experiment? Give a suitable example. (4) CO1
 c. With the help of a suitable illustration show the 2^k design and fit a First order model using Design of Expert approach. (4) CO2
 d. Why Taguchi's approach is preferred as compared to Classical approach of experimental design? Explain with the help of a suitable example. (4) CO2
 e. Discuss any two techniques which can suitably be used for with 3 parameters and 3 levels. (4) CO3
 f. What is the effect of the number of levels in the Taguchi DoE? Explain with the help of an example. (4) CO4
 g. Discuss the measures of variability and concept of confidence level. (4) CO4

SECTION – C

- 4 Answer any one of the following- [5×7=35] CO
 a. What are the characteristic features of an experimental design? Explain the guidelines for designing the experiment. (7) CO1
 b. How do we consider the effect of uncontrolled variables in an experimental design? Briefly explain the significance of variance and residual error in the analysis. (7) CO1
5. Answer any one of the following- (7) CO2
 a. Design an experiment on a lathe machine using four controllable input parameters and two output parameter using factorial design method. How the main and interaction effects of the factors are determined in the factorial design?

- b. An engineer is interested in observing the effect of cutting speed (A), tool geometry (B), and cutting angle (C) on the life (in hours) of a machine tool. Two levels of each factor are chosen, and three replicates of a 2^3 factorial design are run. The results follow: (7) CO2

A	B	C	Treatment Combination	Replicate		
				I	II	III
-	-	-	(1)	22	31	25
+	-	-	a	32	43	29
-	+	-	b	35	34	50
+	+	-	ab	55	47	46
-	-	+	c	44	45	38
+	-	+	ac	40	37	36
-	+	+	bc	60	50	54
+	+	+	abc	39	41	47

Estimate the factor effects. Which effects appear to be large? Use the analysis of variance to confirm your conclusions.

6. Answer any one of the following-

- a. A study was performed on wear of a bearing y and its relationship to x_1 = oil viscosity and x_2 = load. The following data were obtained: (7) CO3

y	x_1	x_2
193	1.6	851
230	15.5	816
172	22.0	1058
91	43.0	1201
113	33.0	1357
125	40.0	1115

Fit a multiple linear regression model to the data.

- b. The yield of a chemical process is related to the concentration of the reactant and the operating temperature. An experiment has been conducted with the following results: (7) CO3

Yield	Concentration	Temperature
81	1.00	150
89	1.00	180
83	2.00	150
91	2.00	180
79	1.00	150
87	1.00	180
84	2.00	150
90	2.00	180

Fit a multiple linear regression model to the data.

7. Answer any one of the following-

- a. How many orthogonal arrays are possible for three factors and three level design? Write any one of them. (7) CO4
- b. How many orthogonal arrays are possible for four factors and two level design? Write any one of them. (7) CO4

8. Answer any one of the following-

- a. A researcher is interested in determining the optimum level of process parameters on an end mill machine to minimize surface roughness. He considers three process parameters each at three levels, as given below. (7) CO3

Symbol	Machining parameters	Unit	Level-1	Level-2	Level-3
A	Cutting speed	(rev/min)	2000	3000	4000
B	Feed rate	(mm/min)	1000	1250	1500
C	Depth of Cut	(mm)	0.05	0.10	0.15

The researcher performs nine experiments according to the Taguchi L9 orthogonal array and measures the surface roughness. The data for roughness are given below:

Experiment Number	A	B	C	Surface roughness
1	1	1	1	3.40
2	1	2	2	3.43
3	1	3	3	3.53
4	2	1	3	2.801
5	2	2	1	3.265
6	2	3	2	3.151
7	3	1	2	0.458
8	3	2	3	0.747
9	3	3	1	1.196

Determine the S/N ratio, perform mean analysis and analysis of variance (ANOVA) to obtain optimum level of the machining parameters.

- b. A researcher is interested in determining the optimum level of Wire EDM process parameters to minimize micro-hardness. He considers three process parameters each at three levels. The process parameters at three levels are given below: (7) CO3

Symbol	Process parameters	Unit	Level 1	Level 2	Level 3
A	Pulse on time	μ s	15	20	25
B	Pulse off time	μ s	3	4	5
C	Current	A	2	3	4

The researcher performs nine experiments according to the Taguchi L9 orthogonal array and measures the surface roughness. The data for roughness are given below.

Experiment Number	A	B	C	Micro-hardness (HV)
1	1	1	1	173.46
2	1	2	2	219.4
3	1	3	3	206.8
4	2	1	3	140.1
5	2	2	1	179.5
6	2	3	2	181.9
7	3	1	2	167.9
8	3	2	3	152.3
9	3	3	1	155.1

Determine the S/N ratio, perform mean analysis and analysis of variance (ANOVA) to determine optimum level of the process parameter.