Exam Date & Time: 07-May-2024 (02:30 PM - 05:30 PM)





MANIPAL ACADEMY OF HIGHER EDUCATION

IV SEMESTER B.TECH (Industrial Engineering) END SEMESTER EXAMINATIONS, APRIL/MAY-2024 DESIGN OF EXPERIMENTS [MIE 2229]

Marks: 50

A

Duration: 180 mins.

Answer all the questions.

Missing data may be suitably assumed

1) Referring the below data table related to studying the effect of temperature and pressure on the yield of a chemical process. Construct the ANOVA table and analyse for the significant effects. Take contrasts as $C_A = 50$, $C_B = -30$ and $C_{AB} = 10$.

A)	Pressure-B	Temperature -A		
		Low (60 ⁰ C)	High (70 ⁰ C)	(4
	Low (100 MPa)	28, 25, 27	36, 32, 32	
	High (150 MPa)	18, 19, 23	31, 30, 29	

B) Explain the different strategy of Experimentation.

(3)

- C) What is mixture design? Explain Simplex-Lattice design. (3)
- In an experiment to develop a nitride etch process on a single-wafer plasma etching tool, the design factors are the (4) gap (A: 0.8 and 1.2 cm) between the electrodes, the gas flow (B: 125 and 200 cm³/min) and the power (C: 275 and 325 W) applied to cathode. The response variable is the etch rate (Angstroms/second). Referring to the etch rate data
 - A) table given below estimate the effects, sum of squares and percent contribution.

	Coded factors			Etch	rate	Treatment
Run	Α	В	с	Replicate- 1	Replicate- 2	combination
1	-1	-1	-1	550	604	(1)
2	1	-1	-1	669	650	а
3	-1	1	-1	633	601	b
4	1	1	-1	642	635	ab
5	-1	-1	1	1037	1052	С
6	1	-1	1	749	868	ас
7	-1	1	1	1075	1063	bc
8	1	1	1	729	860	abc

B) Define the terms: Treatment, factor and level used in DoE.

(3)

- C) What is Taguchi quality loss function? Explain the steps in Robust design. (3)
- A team is trying to improve the strength characteristics of a wall board as measured by the force required to pull a nail (4) through the material. The board is made up of layers of papers pasted together and pressed. The final list of factors is listed below showing the low versus high levels. The objective is to maximize the response. There were two replicates of each run A) and the average force for each run is given in table. Find the effects by *spread sheet approach for eight-run PB design*.

Factors:

A-Paste temperature: 120⁰F vs. 150⁰F

B-Roll pressure: 40 psi vs. 80 psi

C-Amount of sizing: 0.5 % vs. 1.0 %

D-Paste types: X vs. Y

E-Paper moisture: 4 % vs. 8 %

F-Cure time: 5 days vs. 10 days

G-Mill speed: 200 fpm vs. 250 fpm

Run	1	2	3	4	5	6	7	8
Avg. force (Y)	59.75	56.20	70.15	72.60	70.90	55.55	63.20	50.00
S ²	0.61	38.69	3.65	0.02	7.24	73.27	42.10	12.50

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MIE 2229

B) In a study related to manual arc welding, the objective was to maximize the weld strength. In addition to the following control factors at two levels, interactions AD and CD are considered.

A: Weld design

- B: Cleaning method
- C: Pre-heating temperature
- D: Post weld heat treatment
- E: Welding current

Choose a suitable Taguchi OA and assign factors to the columns with the help of corresponding triangular table.

C) List and explain the types of static problems. Write the corresponding S/N ratios.

(3)

(3)

An experiment is run in a chemical process using a factorial design. The design factors are temperature and pressure, and the response variable is yield. The data that result from this experiment are shown below. Analyse the data for main effects and interaction effects by standard method.

A)

4)

Temperature	Pressure (kPa): A				
(⁰C): B	100	120	140		
80	47.58, 48.77	64.97, 69.22	80.92 <i>,</i> 72.60	(4	
90	51.86, 82.43	88.47 <i>,</i> 84.23	93.95 <i>,</i> 88.54		
100	71.18, 92.77	96.57, 88.72	76.58, 83.04		

B) What is response surface methodology? Explain the methods of response surface methodology to obtain the optimum point on response surface.

(3)

(3)

- C) What is full and fractional factorial design? Write the treatment combination table for a full factorial design involving 2-level factors A, B and C along with all possible interactions among them.
- An experiment was conducted to study the effects of Phosphorus (p) and Nitrogen (n) on sugar beets. (4)
 Figure shows the treatment plan and the % of sugar. Find all the effects by applying Yate's method.
 Take the standard order in sequence as pn.

A)



B) Two processes A and B are used to produce a part. The following data has been obtained from the two processes.

Process	Α	В	
Mean	232.2	239	
Standard deviation	207.95	62.10	

The specification for the part is 230 ± 20 . The consumer loss was estimated to be Rs.3000. Determine which process is economical based on quality loss.

C) What is central composite design? Write the structure of central composite design.

(3)

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