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Section 1

MANE 6313

Subsection 1

Week 9, Module E

Student Learning Outcome

- Select an appropriate experimental design with one or more factors,
- Select an appropriate model with one or more factors,
- Evaluate statistical analyses of experimental designs,
- Assess the model adequacy of any experimental design, and
- Interpret model results.

Module Learning Outcome

2^{k-p}

Describe a general 2^(k-p) fractional factorial design.

The general 2^{k-p} Fractional Factorial Design

- A 2^k fractional factorial design containing 2^{k-p} runs is called a $1/2^p$ fraction of the 2^k design
- These designs requires p independent generators (same definition from last week).
- There are $2^p - p - 1$ generalized interactions included
- There is an "art" to selecting the correct generators. Look to table 8.14 (page 353) for suggestions.

p = 1, 1/2
p = 2, 1/4
p = 3, 1/8
p = 4, 1/16

p = 2 → 2^2 - 2 - 1 = 1 GI.
p = 3 → 2^3 - 3 - 1 = 4 GI.

Table 8.14

TABLE 8.14
Selected 2^{k-p} Fractional Factorial Designs

Number of Factors, k	Fraction	Number of Runs	Design Generators
3	2_{III}^{3-1}	4	$C = \pm AB$
4	2_{IV}^{4-1}	8	$D = \pm ABC$
5	2_{V}^{5-1}	16	$E = \pm ABCD$
	2_{III}^{5-2}	8	$D = \pm AB$
			$E = \pm AC$
6	2_{VI}^{6-1}	32	$F = \pm ABCDE$ ✓
	2_{IV}^{6-2}	16	$E = \pm ABC$
			$F = \pm BCD$
	2_{III}^{6-3}	8	$D = \pm AB$
			$E = \pm AC$
			$F = \pm BC$
7	2_{VII}^{7-1}	64	$G = \pm ABCDEF$
	2_{IV}^{7-2}	32	$F = \pm ABCD$
			$G = \pm ABDE$
	2_{IV}^{7-3}	16	$E = \pm ABC$
			$F = \pm BCD$
			$G = \pm ACD$
	2_{III}^{7-4}	8	$D = \pm AB$
			$E = \pm AC$
			$F = \pm BC$
			$G = \pm ABC$
8	2_{V}^{8-2}	64	$G = \pm ABCD$
			$H = \pm ABEF$
	2_{IV}^{8-3}	32	$F = \pm ABC$
			$G = \pm ABD$
			$H = \pm BCDE$
	2_{IV}^{8-4}	16	$E = \pm BCD$
			$F = \pm ACD$
			$G = \pm ABC$
			$H = \pm ABD$
9	2_{VI}^{9-2}	128	$H = \pm ACDFG$
			$J = \pm BCEFG$
	2_{IV}^{9-3}	64	$G = \pm ABCD$
			$H = \pm ACEF$
			$J = \pm CDEF$
	2_{IV}^{9-4}	32	$F = \pm BCDE$
			$G = \pm ACDE$
			$H = \pm ABDE$
	2_{III}^{9-5}	16	$E = \pm ABC$
			$F = \pm BCD$
			$G = \pm ACD$
			$H = \pm ABD$
			$J = \pm ABCD$
10	2_{V}^{10-3}	128	$H = \pm ABCG$
			$J = \pm BCDE$
			$K = \pm ACDF$
	2_{IV}^{10-4}	64	$G = \pm BCDF$
			$H = \pm ACDF$
			$J = \pm ABDE$
			$K = \pm ABCE$
	2_{IV}^{10-5}	32	$F = \pm ABCD$
			$G = \pm ABCE$
			$H = \pm ABDE$
			$J = \pm ACDE$
			$K = \pm BCDE$
	2_{III}^{10-6}	16	$E = \pm ABC$
			$F = \pm BCD$
			$G = \pm ACD$
			$H = \pm ABD$
			$J = \pm ABCD$
			$K = \pm AB$
11	2_{IV}^{11-5}	64	$G = \pm CDE$
			$H = \pm ABCD$
			$J = \pm ABF$
			$K = \pm BDEF$
			$L = \pm ADEF$
	2_{IV}^{11-6}	32	$F = \pm ABC$
			$G = \pm BCD$
			$H = \pm CDE$
			$J = \pm ACD$
			$K = \pm ADE$
			$L = \pm BDE$
	2_{III}^{11-7}	16	$E = \pm ABC$
			$F = \pm BCD$
			$G = \pm ACD$
			$H = \pm ABD$
			$J = \pm ABCD$

Appendix X

X Alias Relationships for 2^{k-p} Fractional Factorial Designs with $k \leq 15$ and $n \leq 64$ (*Continued*)

Designs with 6 Factors

(e) 2^{6-3}; 1/8 fraction of 6 factors in 8 runs **Resolution III**

Design Generators

$D = AB \quad E = AC \quad F = BC$

Defining relation: $I = ABD = ACE = BCDE = BCF = ACDF = ABEF = DEF$

Aliases

$A = BD = CE = CDF = BEF$ $\quad E = AC = DF = BCD = ABF$

$B = AD = CF = CDE = AEF$ $\quad F = BC = DE = ACD = ABE$

$C = AE = BF = BDE = ADF$ $\quad CD = BE = AF = ABC = ADE = BDF = CEF$

$D = AB = EF = BCE = ACF$

Resolution III Designs

- It is possible to construct resolution III designs for investigating up to $k = N - 1$ factors in N runs when N is a multiple of 4
- These experiments are said to be *saturated*
- Pay particular attention to Sequential assembly of fractions to separate effects.

Minitab

- Example problems demonstrate the use of Minitab for fractional factorials
- Minitab provides excellent support