Practice Exam for Design of Experiments

1. Identify all the statements below regarding **DOE** that are **True**:
   - Every process has 3 common features: inputs, the process and technical requirements.
   - The full factorial DOE is the best design to use when your objective is to screen out critical and non-critical factors.
   - Replication increases the sample size and the degrees of freedom allow us to analyze interaction effects using ANOVA.
   - Reducing experimental error increases the accuracy of your conclusions about the effect of each factor in a DOE.

2. Identify all the statements below regarding **DOE** that are **False**:
   - The independent variables (x) associated with a DOE are the outputs of the process.
   - Uncontrollable factors (noise) can cause variation in the response variable that's called systematic error.
   - Response variables represent the outcome of a process or experiment.
   - The estimate of the effects of each factor within a DOE becomes more precise when we replicate an experiment.

3. Identify all the statements below regarding **DOE** that are **True**:
   - A level refers to specific settings of a response variable.
   - One large DOE is considered better than multiple smaller DOE's.
   - A process can have input factors that are uncontrollable.
   - The order of a design refers to the chronological sequence in which you execute the various experiment.

4. Identify all the statements below regarding **DOE** that are **False**:
   - Reducing the effect of an uncontrollable factor would decrease the robustness of the process.
   - Blocking improves the power of a design, but increases the potential for confounding factors.
   - The inputs of a DOE are also referred to as Factors.
   - Unexplainable variation in your response variable is called experimental error.

5. Identify all the statements below regarding **DOE** that are **True**:
   - There are three types of experimental error associated with a DOE - random error, systematic error, and technical error.
   - Interactions can be fully analyzed in a fractional factorial experiment where all possible combinations of levels and factors are studied.
   - A treatment is a unique combination of factors and levels within an experiment.
   - Replicating a design increases the degrees of freedom of the ANOVA analysis to ensure the ability to analyze all interactions.

6. Identify all the statements below regarding **DOE** that are **False**:
   - Each repetition of an experiment is called a treatment.
   - You perform an experiment and the ANOVA analysis indicates that your blocking factor has a statistically significant impact on the response variable. This is an indication that you did not block the experiment appropriately.
   - A full factorial experiment is one in which every combination of factors and levels is included within the experiment.
   - Confounding should be expected to occur when performing a fractional factorial experiment.

7. Error in your measurement system is an example of which type of experimental error in a DOE:
   - Human Error
   - Operator Error
   - Systematic Error
   - Random Error
   - Technical Error

8. How many treatments would be required for a DOE with 6 factors where a half factorial design is chosen:
   - 128
   - 64
   - 32
   - 16
   - 8
   - 4

9. How many treatments would be required for a DOE with 10 factors where a full factorial design is chosen:
    - 64
    - 128
    - 256
    - 512
    - 1024
    - 2048

10. How many treatments would be required for a DOE with 4 factors where a quarter factorial design is chosen:
    - 1
    - 2
    - 4
    - 8
    - 16

11. How many treatments would be required for a DOE with 9 factors where a half factorial design is chosen:
    - 1025
    - 512
    - 256
    - 128
    - 64

12. How many treatments would be required for a DOE with 5 factors where a full factorial design is chosen:
    - 64
    - 32
    - 16
    - 8
    - 4

13. How many treatments would be required for a DOE with 8 factors where a quarter factorial design is chosen:
    - 256
    - 128
    - 64
    - 32
    - 16
    - 8

14. Which Quality Guru is often credited with introducing many innovations in the world of DOE including Design Robustness:
    - W. Edwards Deming
    - Walter Shewhart
    - Joseph M. Juran
    - Genichi Taguchi
    - Kaoru Ishikawa

15. The ANOVA Analysis associated with a DOE assumes your data follows which probability distribution:
    - The Normal Distribution
    - The Exponential Distribution
    - The Poisson Distribution
    - The Binomial Distribution

16. Fill in the blank: A _____ is a statistical method that allows you to study and quantify the relationship between the inputs and outputs of a process or product.
    - Pareto Chart
    - Design of Experiments
    - Control Chart
    - Flow Diagram
    - Scatter Diagram

17. Fill in the blank: _____ is the act of performing a designed experiment all over again.
    - Blocking
    - Randomization
    - Power
    - Replication
    - Robustness

18. Fill in the blank: _____ is the degree to which a product or process is unaffected by the variation of a particular factor.
    - Blocking
    - Randomization
    - Power
    - Replication
    - Robustness

19. Fill in the blank: A _____ design is used to study a process to determine which factors are critical and which are not.
    - Screening/Characterization Design
    - Comparative Design
    - Modeling/Optimization Design
    - Full Factorial Design
    - Orthogonal Array

20. Identify all of the tools below can be used to reduce or eliminate the random error associated with uncontrollable factors within a DOE.
    - Blocking
    - Replication
    - Randomization
    - Confounding
    - Efficiency
    - Power

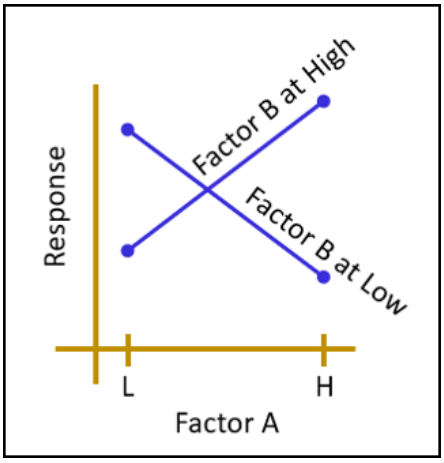
21. Fill in the blank: A _____ is one where all of the treatments have the same number of observations or replications.
    - Balanced Design
    - Full Factorial Design
    - Fractional Factorial
    - Random Design
    - Efficient Design

22. Fill in the blank: A _____ Is one whose order of treatments is determined at random.
    - Blocked Design
    - Efficient Design
    - Randomized Design
    - Orthogonal Design
    - Replicate Design

23. Fill in the blank: Two factors are said to be _____ when the response variable changes when both factors are varied simultaneously.
    - confounding
    - replicates
    - balanced
    - efficient
    - randomized
    - interacting

24. Fill in the blank: Two factors are _____ when their effects are indistinguishably combined to affect the response variable.
    - confounding
    - replicates
    - balanced
    - efficient
    - randomized
    - interacting

25. You performed a DOE and have created the Interaction Effects Plot below, how could you describe the relationship between Factor A & B:
    - The factors are confounding
    - The factors appear balanced and efficient
    - No conclusion can be made, more replicates are needed
    - The treatment order was appropriately randomized
    - The factors appear to be interacting strongly



26. You performed a full factorial DOE to improve the yield of a process with two factors at two levels and have measured the following response values. What is the estimated effect of Factor A:

		Factors		Response
		A	B	% Yield
Treatments	1	+	+	64
	2	-	+	75
	3	+	-	87
	4	-	-	95

- -9.5
- -21.5
- 11
- -1.5
- -8

27. You performed a full factorial DOE to improve the yield of a process with two factors at two levels and have measured the following response values. What is the estimated effect of Factor B:

		Factors		Response
		A	B	% Yield
Treatments	1	+	+	64
	2	-	+	75
	3	+	-	87
	4	-	-	95

- -9.5
- -21.5
- 11
- -1.5
- -8

28. You performed a full factorial DOE to improve the yield of a process with two factors at two levels and have measured the following response values. What is the estimated effect of the interaction between A & B.

		Factors		Response
		A	B	% Yield
Treatments	1	+	+	64
	2	-	+	75
	3	+	-	87
	4	-	-	95

- -9.5
- -21.5
- 11
- -1.5
- -8

29. You performed a full factorial DOE to improve the yield of a process with three factors at two levels.

Identify all of the interaction effects below that should be considered “highs” when analyzing interactions:

		Factors			Interactions		
		A	B	C	AB	AC	BC
Treatments	1	+	+	+		A	
	2	+	+	-	B		
	3	+	-	+		C	
	4	+	-	-			D
	5	-	+	+		E	
	6	-	+	-	F		
	7	-	-	+		G	
	8	-	-	-			H

- A
- B
- C
- D
- E
- F
- G
- H

30. You performed a full factorial DOE to improve the yield of a process with three factors at two levels.

Identify all of the treatments that would be considered “lows” for the second order interaction.

		Factors		
		A	B	C
Treatments	1	+	+	+
	2	+	+	-
	3	+	-	+
	4	+	-	-
	5	-	+	+
	6	-	+	-
	7	-	-	+
	8	-	-	-

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

31. You want to perform a DOE for a process with 4 factors, however you can only afford 6 treatment combinations.

You decide to do a quarter factorial with the following treatments.

Identify all of the confounding main effects or interaction effects:

	Factors				Interactions					
	A	B	C	D	AB	AC	AD	BC	BD	CD
5	-	+	+	+	-	-	-	+	+	+
6	-	+	-	+	-	+	-	-	+	-
11	+	-	+	-	-	+	-	-	+	-
12	+	-	-	-	-	-	-	+	+	+

- Main Effects of Factors A & B
- Main Effects of Factors B & C
- Main Effects of Factors A & D
- Main Effects of Factors B & D
- Interaction Effect AB and Interaction Effect AD
- Interaction Effect BC and Interaction Effect CD
- Interaction Effect AC and Interaction Effect BC
- Interaction Effect BD and Interaction Effect AB

32. You want to perform a DOE for a process with 4 factors, however you can only afford 8 treatment combinations.

You decide to do a half factorial with the following treatments.

Identify all of the confounding main effects or interaction effects:

	Factors				Interactions					
	A	B	C	D	AB	AC	AD	BC	BD	CD
1	+	+	+	+	+	+	+	+	+	+
2	+	+	-	+	+	-	+	-	+	-
3	+	-	+	+	-	+	+	-	-	+
4	+	-	-	+	-	-	+	+	-	-
13	-	+	+	-	-	-	+	+	-	-
14	-	+	-	-	-	+	+	-	-	+
15	-	-	+	-	+	-	+	-	+	-
16	-	-	-	-	+	+	+	+	+	+

- Main Effects of Factors A & B
- Main Effects of Factors B & C
- Main Effects of Factors A & D
- Main Effects of Factors B & D
- Interaction Effect BC and Interaction Effect AC
- Interaction Effect AC and Interaction Effect CD
- Interaction Effect BC and Interaction Effect AD
- Interaction Effect AB and Interaction Effect BD

33. You want to perform a DOE for a process with 4 factors, however you can only afford 8 treatment combinations.

You decide to do a half factorial with the following treatments.

Identify all of the confounding main effects or interaction effects:

		Factors				Interactions					
		Factor A	Factor B	Factor C	Factor D	AB	AC	AD	BC	BD	CD
Treatments	1	+	+	+	+	+	+	+	+	+	+
	3	+	-	-	+	-	-	+	+	-	-
	5	-	+	-	+	-	+	-	-	+	-
	7	-	-	+	+	+	-	-	-	-	+
	9	+	+	+	-	+	+	-	+	-	-
	11	+	-	-	-	-	-	-	+	+	+
	13	-	+	-	-	-	+	+	-	-	+
	15	-	-	+	-	+	-	+	-	+	-

- Main Effects of Factors B & C
- Interaction Effect AD and Interaction Effect CD
- Main Effects of Factors A & the Interaction Effect of AB
- Main Effects of Factors B & C
- Interaction Effect BC and Interaction Effect BD
- Main Effects of Factors B & the Interaction Effect of AC
- Main Effects of Factors A & D
- Interaction Effect AB and Interaction Effect CD
- Main Effects of Factors C & the Interaction Effect of BC

34. You performed a half factorial DOE to improve the yield of a process with four factors at two levels.

Identify all of the interaction effects below that should be considered “lows” when analyzing the interaction effects:

		Factors				Interactions					
		Factor A	Factor B	Factor C	Factor D	AB	AC	AD	BC	BD	CD
Treatments	1	+	+	+	+			A			
	3	+	-	-	+					B	
	5	-	+	-	+	C					
	7	-	-	+	+		D				
	9	+	+	+	-				E		F
	11	+	-	-	-					G	
	13	-	+	-	-		H				
	15	-	-	+	-				I		

- A
- B
- C
- D
- E
- F
- G
- H
- I

Solutions for Practice Exam

1. Identify all the statements below regarding **DOE** that are **True**:
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   - The full factorial DOE is the best design to use when your objective is to screen out critical and non-critical factors.
   - Replication increases the sample size and the degrees of freedom allow us to analyze interaction effects using ANOVA.
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   - There are three types of experimental error associated with a DOE - random error, systematic error, and technical error.
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7. Error in your measurement system is an example of which type of experimental error in a DOE:
   - Human Error
   - Operator Error
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   - Random Error
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8. How many treatments would be required for a DOE with 6 factors where a half factorial design is chosen:
   - 128
   - 64
   - **32**
   - 16
   - 8
   - 4

$$\boldsymbol{Half}\ Factorial\ Design\text{: }Number\ of\ Treatments = \frac{Levels^{Factors}}{2} = 2^{F-1} = 2^{6-1} = 32$$

9. How many treatments would be required for a DOE with 10 factors where a full factorial design is chosen:
   - 64
   - 128
   - 256
   - 512
   - **1024**
   - 2048

$$\boldsymbol{Full}\ Factorial\ Design:\ Number\ of\ Treatments = Levels^{Factors} = 2^{10} = 1024$$

10. How many treatments would be required for a DOE with 4 factors where a quarter factorial design is chosen:
   - 1
   - 2
   - **4**
   - 8
   - 16

$$\boldsymbol{Quarter}\ Factorial\ Design: Number\ of\ Treatments = \frac{Levels^{Factors}}{4} = \frac{L^F}{4} = \frac{2^F}{2^2} = 2^{F-2} = 2^{4-2} = 2^2 = 4$$

11. How many treatments would be required for a DOE with 9 factors where a half factorial design is chosen:
   - 1025
   - 512
   - **256**
   - 128
   - 64

$$\boldsymbol{Half}\ Factorial\ Design: Number\ of\ Treatments = \frac{Levels^{Factors}}{2} = 2^{F-1} = 2^{9-1} = 256$$

12. How many treatments would be required for a DOE with 5 factors where a full factorial design is chosen:
   - 64
   - **32**
   - 16
   - 8
   - 4

$$\boldsymbol{Full}\ Factorial\ Design:\ Number\ of\ Treatments = Levels^{Factors} = 2^5 = 32$$

13. How many treatments would be required for a DOE with 8 factors where a quarter factorial design is chosen:
    - 256
    - 128
    - **64**
    - 32
    - 16
    - 8

$$\textbf{Quarter}\ Factorial\ Design\text{: }Number\ of\ Treatments = \frac{Levels^{Factors}}{4} = \frac{L^F}{4} = \frac{2^F}{2^2} = 2^{8-2} = 2^6 = 64$$

14. Which Quality Guru is often credited with introducing many innovations in the world of DOE including Design Robustness:
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19. Fill in the blank: A _____ design is used to study a process to determine which factors are critical and which are not.
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    - Comparative Design
    - Modeling/Optimization Design
    - Full Factorial Design
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20. Identify all of the tools below can be used to reduce or eliminate the random error associated with uncontrollable factors within a DOE.
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    - **Replication**
    - **Randomization**
    - Confounding
    - Efficiency
    - Power

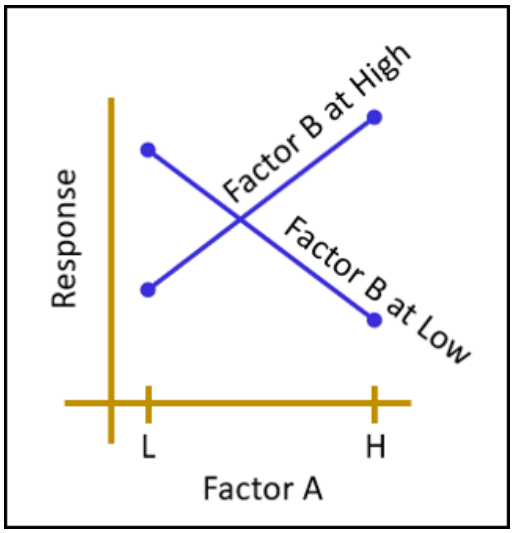
21. Fill in the blank: A _____ is one where all of the treatments have the same number of observations or replications.
    - **Balanced Design**
    - Full Factorial Design
    - Fractional Factorial
    - Random Design
    - Efficient Design

22. Fill in the blank: A _____ Is one whose order of treatments is determined at random.
    - Blocked Design
    - Efficient Design
    - **Randomized Design**
    - Orthogonal Design
    - Replicate Design

23. Fill in the blank: Two factors are said to be _____ when the response variable changes when both factors are varied simultaneously.
    - confounding
    - replicates
    - balanced
    - efficient
    - randomized
    - **interacting**

24. Fill in the blank: Two factors are _____ when their effects are indistinguishably combined to affect the response variable.
    - **confounding**
    - replicates
    - balanced
    - efficient
    - randomized
    - interacting

25. You performed a DOE and have created the **Interaction Effects Plot** below, how could you describe the relationship between Factor A & B:
    - The factors are confounding
    - The factors appear balanced and efficient
    - No conclusion can be made, more replicates are needed
    - The treatment order was appropriately randomized
    - **The factors appear to be interacting strongly**



26. You performed a full factorial DOE to improve the yield of a process with two factors at two levels and have measured the following response values. What is the estimated effect of Factor A:

		Factors		Response
		A	B	% Yield
Treatments	1	+	+	64
	2	-	+	75
	3	+	-	87
	4	-	-	95

- **-9.5**
- -21.5
- 11
- -1.5
- -8

$$\boldsymbol{Estimated\ Effect = Average\ at\ High - Average\ at\ Low}$$

$$\boldsymbol{Factor\ A\ Estimated\ Effect} = \frac{64+87}{2} - \frac{75+95}{2} = -9.5$$

27. You performed a full factorial DOE to improve the yield of a process with two factors at two levels and have measured the following response values. What is the estimated effect of Factor B:

		Factors		Response
		A	B	% Yield
Treatments	1	+	+	64
	2	-	+	75
	3	+	-	87
	4	-	-	95

- -9.5
- **-21.5**
- 11
- -1.5
- -8

$$\boldsymbol{Estimated\ Effect = Average\ at\ High - Average\ at\ Low}$$

$$\boldsymbol{Factor\ A\ Estimated\ Effect} = \frac{64+75}{2} - \frac{87+95}{2} = -21.5$$

28. You performed a full factorial DOE to improve the yield of a process with two factors at two levels and have measured the following response values. What is the estimated effect of the interaction between A & B.

		Factors		Response
		A	B	% Yield
Treatments	1	+	+	64
	2	-	+	75
	3	+	-	87
	4	-	-	95

- -9.5
- -21.5
- 11
- **-1.5**
- -8

Estimating the interaction effect means expanding the design matrix to include the interactions.

		Factors		Interactions	Response
		A	B	AB	% Yield
Treatments	1	+	+	+	64
	2	-	+	-	75
	3	+	-	-	87
	4	-	-	+	95

Now we can perform the calculation for the interaction effect:

$$\boldsymbol{Estimated\ Effect = Average\ at\ High - Average\ at\ Low}$$

$$\boldsymbol{Factor\ A\ Estimated\ Effect} = \frac{64+95}{2} - \frac{75+87}{2} = -1.5$$

29. You performed a full factorial DOE to improve the yield of a process with three factors at two levels. Identify all of the interaction effects below that should be considered "highs" when analyzing interactions:

		Factors			Interactions		
		A	B	C	AB	AC	BC
Treatments	1	+	+	+		A	
	2	+	+	-	B		
	3	+	-	+		C	
	4	+	-	-			D
	5	-	+	+		E	
	6	-	+	-	F		
	7	-	-	+		G	
	8	-	-	-			H

- **A**
- **B**
- **C**
- **D**
- E
- F
- G
- **H**

If we complete the interaction design matrix, we can see which of the interactions would be considered "highs" for the interaction between the factors.

		Factors			Interactions		
		A	B	C	AB	AC	BC
Treatments	1	+	+	+	+	+	+
	2	+	+	-	+	-	-
	3	+	-	+	-	+	-
	4	+	-	-	-	-	+
	5	-	+	+	-	-	+
	6	-	+	-	-	+	-
	7	-	-	+	+	-	-
	8	-	-	-	+	+	+

30. You performed a full factorial DOE to improve the yield of a process with three factors at two levels. Identify all of the treatments that would be considered "lows" for the second order interaction.

		Factors		
		A	B	C
Treatments	1	+	+	+
	2	+	+	-
	3	+	-	+
	4	+	-	-
	5	-	+	+
	6	-	+	-
	7	-	-	+
	8	-	-	-

- 1
- **2**
- **3**
- 4
- **5**
- 6
- 7
- **8**

The first order interactions are AB, AC and BC. In this situation there is only 1x second order interaction – ABC.

Let's analyze the design matrix to determine the highs and lows for ABC. Based on this analysis, treatments 2,3,5 and 8 would represent the "lows" for the second order interaction (ABC).

		Factors			Interactions
		A	B	C	ABC
Treatments	1	+	+	+	+
	2	+	+	-	-
	3	+	-	+	-
	4	+	-	-	+
	5	-	+	+	-
	6	-	+	-	+
	7	-	-	+	+
	8	-	-	-	-

31. You want to perform a DOE for a process with 4 factors, however you can only afford 6 treatment combinations.

    you decide to do a quarter factorial with the following treatments.

    Identify all of the confounding main effects or interaction effects:

	Factors				Interactions					
	A	B	C	D	AB	AC	AD	BC	BD	CD
5	-	+	+	+	-	-	-	+	+	+
6	-	+	-	+	-	+	-	-	+	-
11	+	-	+	-	-	+	-	-	+	-
12	+	-	-	-	-	-	-	+	+	+

- Main Effects of Factors A & B
- Main Effects of Factors B & C
- Main Effects of Factors A & D
- **Main Effects of Factors B & D**
- **Interaction Effect AB and Interaction Effect AD**
- **Interaction Effect BC and Interaction Effect CD**
- Interaction Effect AC and Interaction Effect BC
- Interaction Effect BD and Interaction Effect AB

	Factors				Interactions					
	A	B	C	D	AB	AC	AD	BC	BD	CD
5	-	+	+	+	-	-	-	+	+	+
6	-	+	-	+	-	+	-	-	+	-
11	+	-	+	-	-	+	-	-	+	-
12	+	-	-	-	-	-	-	+	+	+

32. You want to perform a DOE for a process with 4 factors, however you can only afford 8 treatment combinations.

You decide to do a half factorial with the following treatments.

Identify all of the confounding main effects or interaction effects:

	Factors				Interactions					
	A	B	C	D	AB	AC	AD	BC	BD	CD
1	+	+	+	+	+	+	+	+	+	+
2	+	+	-	+	+	-	+	-	+	-
3	+	-	+	+	-	+	+	-	-	+
4	+	-	-	+	-	-	+	+	-	-
13	-	+	+	-	-	-	+	+	-	-
14	-	+	-	-	-	+	+	-	-	+
15	-	-	+	-	+	-	+	-	+	-
16	-	-	-	-	+	+	+	+	+	+

- Main Effects of Factors A & B
- Main Effects of Factors B & C
- **Main Effects of Factors A & D**
- Main Effects of Factors B & D
- Interaction Effect BC and Interaction Effect AC
- **Interaction Effect AC and Interaction Effect CD**
- Interaction Effect BC and Interaction Effect AD
- **Interaction Effect AB and Interaction Effect BD**

	Factors				Interactions					
	A	B	C	D	AB	AC	AD	BC	BD	CD
1	+	+	+	+	+	+	+	+	+	+
2	+	+	-	+	+	-	+	-	+	-
3	+	-	+	+	-	+	+	-	-	+
4	+	-	-	+	-	-	+	+	-	-
13	-	+	+	-	-	-	+	+	-	-
14	-	+	-	-	-	+	+	-	-	+
15	-	-	+	-	+	-	+	-	+	-
16	-	-	-	-	+	+	+	+	+	+

33. You want to perform a DOE for a process with 4 factors, however you can only afford 8 treatment combinations.

You decide to do a half factorial with the following treatments.

Identify all of the confounding main effects or interaction effects:

		Factors				Interactions					
		Factor A	Factor B	Factor C	Factor D	AB	AC	AD	BC	BD	CD
Treatments	1	+	+	+	+	+	+	+	+	+	+
	3	+	-	-	+	-	-	+	+	-	-
	5	-	+	-	+	-	+	-	-	+	-
	7	-	-	+	+	+	-	-	-	-	+
	9	+	+	+	-	+	+	-	+	-	-
	11	+	-	-	-	-	-	-	+	+	+
	13	-	+	-	-	-	+	+	-	-	+
	15	-	-	+	-	+	-	+	-	+	-

- Main Effects of Factors B & C
- Interaction Effect AD and Interaction Effect CD
- **Main Effects of Factors A & the Interaction Effect of AB**
- Main Effects of Factors B & C
- Interaction Effect BC and Interaction Effect BD
- **Main Effects of Factors B & the Interaction Effect of AC**
- Main Effects of Factors A & D
- Interaction Effect AB and Interaction Effect CD
- **Main Effects of Factors C & the Interaction Effect of BC**

		Factors				Interactions					
		Factor A	Factor B	Factor C	Factor D	AB	AC	AD	BC	BD	CD
Treatments	1	+	+	+	+	+	+	+	+	+	+
	3	+	-	-	+	-	-	+	+	-	-
	5	-	+	-	+	-	+	-	-	+	-
	7	-	-	+	+	+	-	-	-	-	+
	9	+	+	+	-	+	+	-	+	-	-
	11	+	-	-	-	-	-	-	+	+	+
	13	-	+	-	-	-	+	+	-	-	+
	15	-	-	+	-	+	-	+	-	+	-

34. You performed a half factorial DOE to improve the yield of a process with four factors at two levels.

Identify all of the interaction effects below that should be considered "lows" when analyzing the interaction effects:

		Factors				Interactions					
		Factor A	Factor B	Factor C	Factor D	AB	AC	AD	BC	BD	CD
Treatments	1	+	+	+	+			A			
	3	+	-	-	+					B	
	5	-	+	-	+	C					
	7	-	-	+	+		D				
	9	+	+	+	-				E		F
	11	+	-	-	-					G	
	13	-	+	-	-		H				
	15	-	-	+	-				I		

- A
- **B**
- **C**
- **D**
- E
- **F**
- G
- H
- **I**

If we complete the interaction design matrix, we can see which of the interactions would be considered "lows" for the interaction between the factors.

		Factors				Interactions					
		Factor A	Factor B	Factor C	Factor D	AB	AC	AD	BC	BD	CD
Treatments	1	+	+	+	+	+	+	+	+	+	+
	3	+	-	-	+	-	-	+	+	-	-
	5	-	+	-	+	-	+	-	-	+	-
	7	-	-	+	+	+	-	-	-	-	+
	9	+	+	+	-	+	+	-	+	-	-
	11	+	-	-	-	-	-	-	+	+	+
	13	-	+	-	-	-	+	+	-	-	+
	15	-	-	+	-	+	-	+	-	+	-