Assignment 10  
Design of Experiments (DOE)

Instructions:
1. Total No. of Questions: 25. Each question carries one point.
2. All questions are objective type. Only one answer is correct per numbered item.
3. In the questions 7, 8 and 10 a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice
4. Questions no. 22 and 23 are common data question

1. Which of the following is true?
   a) Having more than one dependent variable allows the examination of interactions between them.
   b) There must be the same number of independent variables as there are dependent variables.
   c) An experiment can have more than one dependent variable.
   d) An experiment can only have one dependent variable.

2. There are 30 students in each experimental condition in a 5x4 between-groups design, how many participants would be needed in total?
   a) 600
   b) 20
   c) 400
   d) 30

3. Match the followings

<table>
<thead>
<tr>
<th>Type of variables</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Independent variables</td>
<td>1) Those things that you might like to hold constant when a process is running.</td>
</tr>
<tr>
<td>b) Dependent variables</td>
<td>2) Correlated with independent variables</td>
</tr>
<tr>
<td>c) Random variables</td>
<td>3) Factors that we manipulate in an experiment</td>
</tr>
<tr>
<td>d) Confounding variables</td>
<td>4) Factors that you are not controlling and no one is manipulating them and they are changing on their own</td>
</tr>
</tbody>
</table>

   a) a-4, b-2, c-3, d-1
   b) a-3, b-1, c-4, d-2
   c) a-3, b-4, c-1, d-2
   d) a-4, b-3, c-2, d-1

4. ANOVA is a statistical method of comparing the ________ of several populations
   a) Variance
   b) Standard deviations
   c) Means
   d) All of the above
5. To find out whether noise affects the capability to solve the assignment of Quality management, one group solve the assignment in a silent room and another group solve the assignment in a noisy room. The group solving problems in the silent room completes 22 problems in one hour and the group solving problems in the noisy room completes 15 problems in one hour. In this experiment, the independent variable is ____________ and the dependent variable is ____________.
   a) The difficulty of the problem; the noise level in the room
   b) The noise level in the room; the difficulty of the problem
   c) The noise level in the room; the number of problem solved
   d) The number of problems solved; the noise level in the room

6. Read the following statements carefully. Mark the correct choice

   **Statement 1:** Replication is the repetition of an experimental condition so that the variability associated with the phenomenon can be estimated.
   **Statement 2:** Randomization is a way when there may be a factor that might be impacting your process but, you are interested in neutralising that effect.
   **Statement 3:** Blocking is the process of assigning the various levels of the investigated factors to the experimental units in a random fashion.

   a) Statement 1 and 2 is correct
   b) Only statement 1 is correct
   c) Statement 2 and 3 is correct
   d) Only statement 2 is correct

7. **Assertion (A):** Many statistical techniques like histograms, pareto charts, run charts, these are techniques that almost anyone can use and work force should be trained on these techniques

   **Reason (R):** DOE, Regression model, significance tests and confidence interval are most advanced statistical techniques which are all used if you are trying to optimize the process

   a) Both A and R are true, and A is the followed by R
   b) Both A and R are true, but A is not followed by R
   c) A is true, But R is false
   d) Both A and R are false

8. **Assertion (A):** When we are trying to conduct the experiments, do not run the experiments of noisy conditions; try to raise your experimental conditions in such a way, that we are able to obtain better result

   **Reason (R):** We can include the noisy condition in our study, when we want noise also part of our experimental study.

   a) Both A and R are true, and A is the followed by R
   b) Both A and R are true, but A is not followed by R
   c) A is true, But R is false
   d) A is false, but R is true

9. Received Signal Strength Indicator (RSSI) is used to determine

   a) The traffic utilization ratio
   b) The information security system
   c) The location of vehicle
   d) The carbon emission of the vehicle
10. **Assertion (A):** Taguchi approach is a simplified version of partial factor designs; and it requires analyse of variance.
   **Reason (R):** We need not really run the full factorial experiment, and would still be able to come up with reasonably good inference

   a) Both A and R are true, and A is the followed by R
   b) Both A and R are true, but A is not followed by R
   c) A is true, But R is false
   d) A is false, but R is true

11. Factors in a factorial design are the ________.
    a) The experimental variables
    b) The independent variables
    c) The dependent variables
    d) The organismic variables

12. Following table is the example of testing of Ignition coil to determine if it will withstand salt water. Find out which one is the design factor (D) and noise factor (N).

<table>
<thead>
<tr>
<th>Factor</th>
<th>Low level</th>
<th>High level</th>
<th>Factor type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing Material</td>
<td>Polyethylene</td>
<td>Polypropylene</td>
<td>?</td>
</tr>
<tr>
<td>Water temperature</td>
<td>5ºC</td>
<td>15ºC</td>
<td>?</td>
</tr>
<tr>
<td>Seal Thickness</td>
<td>0.02”</td>
<td>0.03”</td>
<td>?</td>
</tr>
<tr>
<td>Water Pressure</td>
<td>10 PSI</td>
<td>20 PSI</td>
<td>?</td>
</tr>
<tr>
<td>Exposure Time</td>
<td>1 hr</td>
<td>5 hrs</td>
<td>?</td>
</tr>
</tbody>
</table>

   a) D, N, D, N, N
   b) N, D, N, D, D
   c) D, D, N, D, N
   d) N, N, D, N, D

13. What will be the correct sequence of DOE to understand the process settings
   a) Interpret result-Perform experiments-Prediction model-optimize the function
   b) Perform experiments-Interpret result-Prediction model-optimize the function
   c) Perform experiments-Interpret result- optimize the function- Prediction model
   d) Perform experiments-Prediction model-Interpret result- optimize the function

14. What must we include when reporting an ANOVA?
   a) Standard deviations
   b) Means
   c) Degrees of freedom
   d) All of these

15. What statistical procedure is used to assess the statistical significance of the main effects and the interaction(s) in a factorial design?
   a) Analysis of covariance
   b) Correlation
   c) T-test
   d) Analysis of variance
16. Dr Rao conducted a response surface (RMS) experiment to design a laboratory, for this they considered three factors temperature (T), pressure (P) and durability (D). Which of the following equation is correct for RMS experiment?

- \( Y = a_1 + a_2 T + a_3 P + a_4 D + a_1 T P + a_2 T D + a_3 P D + a_4 T D + a_5 P D \)
- \( Y = a_1 + a_2 T + a_3 P + a_4 D + a_5 T^2 + a_6 P^2 + a_7 D^2 + a_8 T^2 + a_9 P^2 + a_{10} D^2 \)
- \( Y = a_1 + a_2 T + a_3 P + a_4 D + a_5 T^2 + a_6 P^2 + a_7 D^2 + a_8 T P + a_9 T D + a_{10} P D \)
- \( Y = a_1 + a_2 T + a_3 P + a_4 D + a_5 T P + a_6 T D + a_7 P D + a_8 T^2 + a_9 P^2 + a_{10} D^2 \)

17. One of the researchers from IIT kharagpur conducted a 2x3x2 factorial design experiment for variables A,B,C. This design will yield information about the _________

- a) The design has 12 independent variables
- b) The design has two independent variables at level A, three independent variables at level B, and two independent variables at level C
- c) The design has two independent variables, three dependent variables, and two organismic variables.
- d) The design has three independent variables, two levels of A, three levels of B, and two levels of C.

18. Match the followings

<table>
<thead>
<tr>
<th>Response</th>
<th>S/N Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) When the target performance is best</td>
<td>1) ( SN = -10 \log \frac{\sum (Y^2)}{n} )</td>
</tr>
<tr>
<td>b) When response is to be maximized</td>
<td>2) ( SN = 10 \log \left( \frac{\bar{Y}^2}{S^2} \right) )</td>
</tr>
<tr>
<td>c) When response is to be minimized</td>
<td>3) ( SN = -10 \log \frac{\sum \left( \frac{1}{Y^2} \right)}{n} )</td>
</tr>
</tbody>
</table>

- a) a-1, b-2, c-3
- b) a-2, b-3, c-1
- c) a-1, b-3, c-2
- d) a-3, b-1, c-2

19. Read the following statements carefully. Mark the correct choice

**Statement 1:** The DOE using Taguchi approach can economically satisfy the needs of problem solving and product/process design optimization projects.

**Statement 2:** By learning and applying this technique, engineers, scientists, and researchers can significantly reduce the time required for experimental investigations.

- a) Only statement 1 is correct
- b) Only statement 2 is correct
- c) Statement 1 and 2 is correct
- d) Both statement is wrong
20. Factorial designs allow us to study both ______ effects of the independent variables on the dependent(s).
   a) Main and interactive
   b) Rank order and correlational
   c) Symbiotic and dichotomous
   d) Dependent and independent

21. Which one of the following statement is wrong in reference to one-factor-at-a-time (OFAT) experimentation strategy?
   a) Vary factors together in a specific manner
   b) Involving the testing of factors, or causes, one at a time
   c) OFAT requires more runs for the same precision in effect estimation
   d) OFAT can be more effective than fractional factorials under certain conditions

**Common Data Questions: Questions 22 and 23**

An experiment is conduct to investigate the distortion of drive gears in automobiles. Two factors were included for finding out the effects, i.e. size of the gear (Y1) and the part positioning (Y2). A study of eight gears for each tooth size and part positioning combination is displayed in the following Table.

<table>
<thead>
<tr>
<th>Tooth size</th>
<th>Part Positioning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Y2=Low</td>
</tr>
<tr>
<td>Y1= Low</td>
<td></td>
</tr>
<tr>
<td>18.0</td>
<td>13.5</td>
</tr>
<tr>
<td>16.5</td>
<td>8.5</td>
</tr>
<tr>
<td>26.0</td>
<td>11.5</td>
</tr>
<tr>
<td>22.5</td>
<td>16.0</td>
</tr>
<tr>
<td>21.5</td>
<td>-4.5</td>
</tr>
<tr>
<td>21.0</td>
<td>4.0</td>
</tr>
<tr>
<td>30.0</td>
<td>1.0</td>
</tr>
<tr>
<td>24.5</td>
<td>9.0</td>
</tr>
<tr>
<td>Y1=High</td>
<td></td>
</tr>
<tr>
<td>27.5</td>
<td>17.5</td>
</tr>
<tr>
<td>19.5</td>
<td>11.5</td>
</tr>
<tr>
<td>31.0</td>
<td>10.0</td>
</tr>
<tr>
<td>27.0</td>
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<tr>
<td>17.0</td>
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<tr>
<td>18.0</td>
<td>7.5</td>
</tr>
<tr>
<td>17.5</td>
<td>6.5</td>
</tr>
</tbody>
</table>

22. What will be the effect of low level and high level of tooth size?
   a) Slight rise from 14.9375 to 15.2188 because of change is made from low level to high level effect
   b) A rise from 21.9688 to 8.1875 because of change is made from low level to high level effect
   c) Slight drop from 14.9375 to 15.2188 because of change is made from low level to high level effect
   d) A drop from 21.9688 to 8.1875 because of change is made from low level to high level effect
23. What will be the effect of low level and high level of part positioning?
   a) Slight rise from 14.9375 to 15.2188 because of change is made from low level to high level effect
   b) Slight drop from 14.9375 to 15.2188 because of change is made from low level to high level effect
   c) A drop from 21.9688 to 8.1875 because of change is made from low level to high level effect
   d) A rise from 21.9688 to 8.1875 because of change is made from low level to high level effect

24. In a factorial experiments
   a) Testing one factor at a time
   b) Cannot estimate interactions
   c) all possible combination of factor levels are tested
   d) all of the above

25. Which of the following terms best describe an interaction effect?
   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

Answers Key

<table>
<thead>
<tr>
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<th>1</th>
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