Assignment 12
Six Sigma in Supply Chain, Taguchi Method and Robust Design

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.

1. Determine the signal to noise ratio for the following data 3, 5, 6, 8, 9?
   a) 2.5974
   b) 3.8463
   c) 1.8935
   d) 4.2182

2. A company makes bicycles. It produces 450 bicycles a month. It buys the tyres for bicycles from a supplier at a cost of Rs 120.00 per tyre. The company’s inventory carrying cost is estimated to be 15% of the cost and the ordering is Rs 300.00 per order. Calculate the economic order quantity.
   a) 500
   b) 900
   c) 600
   d) 300

3. An experimenter has identified three controllable factors for a plastic moulding process. Each factor can be applied at two levels as shown in table. What will be the optimum combination of the levels of these factors?

<table>
<thead>
<tr>
<th>FACTORS/LEVELS</th>
<th>A. Injection Pressure</th>
<th>B. Mould Temperature</th>
<th>C. Set Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEVEL 1</td>
<td>A_1 = 250 psi</td>
<td>B_1 = 150°F</td>
<td>C_1 = 6 sec.</td>
</tr>
<tr>
<td>LEVEL 2</td>
<td>A_2 = 350 psi</td>
<td>B_2 = 200°F</td>
<td>C_2 = 9 sec.</td>
</tr>
</tbody>
</table>

   a) An OA of L_8 is suitable
   b) An OA of L_4 is suitable
   c) An OA of L_{16} is suitable
   d) None of the above

4. A design that results in products or services that can function over a broad range of usage and environmental conditions is known as:
   a) Product Design
   b) Quality Design
   c) Flexible Design
   d) Robust Design
5. Which of the following is a customer satisfaction oriented benefit of TQM in Supply Chain Management?

a) Improvement in product service  
b) Reduction in operating cost  
c) Reduction in field service cost  
d) Reduction in liability exposure

6. Which of the following equation is used by Taguchi to calculate SN ratio when response is to be maximized?

a) \( SN_t = -10\log\left(\frac{\bar{y}^2}{s^2}\right) \)

b) \( SN_t = -10\log\left(\frac{\sum y^2}{n}\right) \)

c) \( SN_t = -10\log\left(\frac{\sum x^2}{n}\right) \)

d) None of the above

7. Match the following Taguchi Orthogonal Array table properly.

<table>
<thead>
<tr>
<th>I</th>
<th>2-Level (Fractional Factorial) arrays</th>
<th>A. L_{12}(2^{11})</th>
</tr>
</thead>
<tbody>
<tr>
<td>II</td>
<td>2-Level array</td>
<td>B. L_{28}(5^6)</td>
</tr>
<tr>
<td>III</td>
<td>3-Level array</td>
<td>C. L_{16}(4^3)</td>
</tr>
<tr>
<td>IV</td>
<td>4-Level array</td>
<td>D. L_6(2^4)</td>
</tr>
<tr>
<td>V</td>
<td>5-Level array</td>
<td>E. L_{50}(2^6 \times 5^{11})</td>
</tr>
<tr>
<td>VI</td>
<td>Mixed-Level arrays</td>
<td>F. L_{27}(3^{17})</td>
</tr>
</tbody>
</table>

a) I-C,II-F,III-A,IV-E,V-B,VI-D  
b) I-F,II-E,III-D,IV-A,V-C,VI-B  
c) I-D,II-A,III-F,IV-C,V-B,VI-E  
d) I-E,II-D,III-F,IV-B,V-A,VI-C

8. What is the goal of the supply chain management?

a) To produce value for the ultimate customer  
b) To reduce organizational inefficiencies  
c) To make inventory readily available in customer facing positions to fulfil demand.  
d) All of the above
9. Which of the statement is correct regarding Taguchi’s Noise factors?
   I. Design specifications come under Noise Factors.
   II. Environmental specifications come under Noise Factors.
   III. Quality specifications come under Noise Factors.
      a) Both I and II are correct.
      b) Both II and III are correct.
      c) Both I and III are correct.
      d) All are correct.

10. GA can only be applied to problems that satisfy
    I. The fitness function can be well-defined.
    II. Solutions should be decomposable into steps (building blocks) which could be then encoded as chromosomes.

    a) Only I is correct
    b) None is correct
    c) Only II is correct
    d) Both I and II is correct

11. Which of the statement is correct regarding the link between Quality and Productivity?
    I. Effective quality improvement can be instrumental in increasing productivity and reducing cost.
    II. The cost of achieving quality improvements and increased productivity is often negligible.

    a) Only I
    b) Only II
    c) Both I and II
    d) None

12. A tile manufacturing company test its products according to the Taguchi’s Orthogonal Experimental Plan with 7 factors (A, B, C, D, E, F and G) which may potentially influence the production of defective tiles. The factors were chosen between two extremes like A1 and A2, B1 and B2 likewise. The experiment table given below. Looking at the experiment table propose the optimum combination of factors to see minimum defects.
### Process Variable

<table>
<thead>
<tr>
<th>Expt#</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>Fraction of tiles found defective</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A₁</td>
<td>B₁</td>
<td>C₁</td>
<td>D₁</td>
<td>E₁</td>
<td>F₁</td>
<td>G₁</td>
<td>16/100</td>
</tr>
<tr>
<td>2</td>
<td>A₁</td>
<td>B₁</td>
<td>C₁</td>
<td>D₂</td>
<td>E₂</td>
<td>F₂</td>
<td>G₂</td>
<td>17/100</td>
</tr>
<tr>
<td>3</td>
<td>A₁</td>
<td>B₂</td>
<td>C₂</td>
<td>D₁</td>
<td>E₁</td>
<td>F₂</td>
<td>G₂</td>
<td>12/100</td>
</tr>
<tr>
<td>4</td>
<td>A₁</td>
<td>B₂</td>
<td>C₂</td>
<td>D₂</td>
<td>E₂</td>
<td>F₁</td>
<td>G₁</td>
<td>06/100</td>
</tr>
<tr>
<td>5</td>
<td>A₂</td>
<td>B₁</td>
<td>C₂</td>
<td>D₁</td>
<td>E₂</td>
<td>F₁</td>
<td>G₂</td>
<td>06/100</td>
</tr>
<tr>
<td>6</td>
<td>A₂</td>
<td>B₁</td>
<td>C₂</td>
<td>D₂</td>
<td>E₁</td>
<td>F₂</td>
<td>G₁</td>
<td>68/100</td>
</tr>
<tr>
<td>7</td>
<td>A₂</td>
<td>B₂</td>
<td>C₁</td>
<td>D₁</td>
<td>E₂</td>
<td>F₂</td>
<td>G₁</td>
<td>42/100</td>
</tr>
<tr>
<td>8</td>
<td>A₂</td>
<td>B₂</td>
<td>C₁</td>
<td>D₂</td>
<td>E₁</td>
<td>F₁</td>
<td>G₂</td>
<td>26/100</td>
</tr>
</tbody>
</table>

a) $A_1, B_2, C_2, D_1, E_2, F_1, G_2$
b) $A_2, B_1, C_2, D_2, E_2, F_2, G_1$
c) $A_1, B_1, C_1, D_1, E_1, F_1, G_2$
d) $A_2, B_2, C_1, D_2, E_1, F_2, G_1$

13. How a designer can get maximum robustness of a design?

a) By maximizing SN ratio
b) By maximizing sensitivity to noise
c) By minimizing SN ratio
d) None of the above

14. Regarding supply chain which statement is correct?

a) Information and goods flow in one direction and the money flow in the other direction.
b) Information and money flow in one direction and the goods flow in the other direction.
c) Money and goods flow in one direction and the information flow in the other direction.
d) None of the above.
15. Match the following examples with different factors of robust design.

<table>
<thead>
<tr>
<th>I. Control Factor</th>
<th>A. Operating Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>II. Noise Factor</td>
<td>B. Position of the gas pedal</td>
</tr>
<tr>
<td>III. Adjustment Factor</td>
<td>C. Dimensions of parts</td>
</tr>
<tr>
<td>IV. Signal Factor</td>
<td>D. Deposition time in silicon wafer fabrication</td>
</tr>
</tbody>
</table>

a) I-D,II-B,III-A,IV-C  
b) I-C,II-B,III-D,IV-A  
c) I-D,II-A,III-B,IV-D  
d) I-C,II-A,III-D,IV-B

16. What is the weakness of Taguchi’s Method?

a) Taguchi assumes all factors  
b) Taguchi ignores interactions  
c) Taguchi considers Orthogonal Array  
d) Taguchi considers noise factors

17. Assume you have a product with the following parameters:

- Demand = 360
- Holding cost per year = Rs 1.00 per unit
- Ordering cost = Rs 100.00 per order

What is the total cost for the economic ordered quantity?

a) Rs 348.34  
b) Rs 187.24  
c) Rs 268.33  
d) Rs 441.54

18. The loss function addressed by Taguchi for variability takes which form? Where L is the loss function, k is a constant, y is the independent variable, m is the specification nominal value.

a) \( L = k(y - m)^2 \)  
b) \( L = k(y - m) \)  
c) \( L = k(y - m)^3 \)  
d) \( L = k \times \ln(y - m) \)

19. The aim of Just-In-Time manufacturing principle is to eliminate

a) Time wastage  
b) Labour wastage  
c) Cost of excessive inventory  
d) All of the above
20. What are the invisible causes of large inventories?
   I. Work load imbalance
   II. Worker absenteeism
   III. Machine breakdown
   IV. Quality problems

   a) I, III and IV
   b) I, II and IV
   c) II, III and IV
   d) I, II and III

21. Which of the following is not an important feature of genetic algorithm?

   a) Encoding
   b) Fitness Function
   c) Mutation
   d) Decoding

22. Suppose a genetic algorithm uses chromosomes of the form \( x = abcdefgh \) with a fixed length of eight genes. Each gene can be any digit between 0 and 9. Let the fitness of individual \( x \) be calculated as:
\[
 f(x) = (a + b) - (c + d) + (e + f) - (g + h)
\]
Let the initial population consist of four individuals with the following chromosomes:
\[
x_1 = 65413532
\]
\[
x_2 = 87126601
\]
\[
x_3 = 23921285
\]
\[
x_4 = 41852094
\]
Arrange the individual according to the decreasing order of fitness using Genetic Algorithm.

   a) \( x_1 > x_2 > x_4 > x_3 \)
   b) \( x_2 > x_1 > x_3 > x_4 \)
   c) \( x_3 > x_2 > x_1 > x_4 \)
   d) \( x_4 > x_2 > x_1 > x_3 \)

23. A great deal of inventory piles up along the supply chain due to

   a) Poor quality of supplies
   b) Poor management of logistics and no monitoring of lead times
   c) Quality of finished goods may not be high enough to support JIT mode of operation in your customer’s operations
   d) All of the above
24. Given that the cost of scrapping a part is Rs 10.00 when it deteriorates from a target by ±0.50 mm. what will be the quadratic loss function for a given m of 0.0?

   a) \( L = 20(y - 0)^2 \)
   b) \( L = 10(y - 0)^2 \)
   c) \( L = 40(y - 0)^2 \)
   d) \( L = 30(y - 0)^2 \)

25. Under what conditions would you recommend using a compound noise factor?

   a) When the cost of experiment is high compared to the additional accuracy provided by other noise strategies.
   b) When the profit of the experiment is low compared to the additional accuracy provided by other noise strategies.
   c) When the impact of the experiment is high compared to the additional accuracy provided by other noise strategies.
   d) When the cost of experiment is low compared to the additional accuracy provided by other noise strategies.

Answer Key

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