DATE: 03/11/2022   **Maximum Marks: 40 (weightage 30%)**
                                                                                                                Time: 1.5 Hours

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Instructions:

- All parts of a question must be answered in sequence.
- Support your answers with neat plots wherever required
- Printed statistical tables and charts are not required.

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Data: $Z_{-0.6}=0.2743$, $Z_{2.168}=0.9850$, $Z_{3.0}=0.9987$, $Z_{-3.0}=0.0013$, $Z_{1.17}=0.8790$, $Z_{-4.82}=0.0000$, $t_{0.025, 18}=2.101$

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Q.1 With neat charts, flow diagrams and examples, discuss the Deming's philosophy of quality management and improvement with reference to the following points:

i) Principle of vendor selection ii) PDCA cycle. iii) Exhortations on the workforce.   **[6]**

Q.2 A restaurant believes that time taken to serve the customer is one of the important factors to attract and retain customers. Based on the service times for similar items in the neighboring restaurant, the customer tolerance limit was estimated as 10 minutes, the associated customer loss for which is Rs.200/-. A random sample size of 10 customers yields the following value of service times (in minutes): 5.2,7.5,4.8,11.4,9.8,10.5,8.2,11,12,8.5. If the restaurant serves 5,000 customers in a month, find the expected monthly loss. If the restaurant hires more personnel at an additional cost of Rs. 20/- per customer, following service times are observed: 8.4,5.6,7.8,6.8,8.5,6.2,6.5,5.9,6.4,7.5. Is it cost effective to add personnel? What is the total expected monthly loss?   **[2x4=8]**

Q.3a) The diameter of bearings is known to be normally distributed having a mean of 35 mm with a standard deviation of 0.5 mm. A random sample of 36 bearings is selected. What percentage of these bearings will have average diameter between 34.95 and 35.18 mm?   **[4]**

b) It has been estimated that 60% of all solar installations reduce the electricity bill by at least one third. What is the probability that the electricity bill will be reduced by at least one third, in four out of five installations?   **[2]**

Q.4 The initial cost of inspection of a gear used in a transmission system is estimated to be ₹ 150/- (INR). If a non-conforming gear is allowed in the assembly, the cost of eventually disassembling the same and replace it is ₹ 36000/-. It is known that around 0.3% gears may be non-conforming in a weekly production of 3000 gears.

i) Using the Deming's *k-p* rule, arrive at a decision on the kind of inspection policy the organization should adapt. Support your decision with the required values.

ii) What is the average weekly saving or loss in ₹, if the organization follows a policy of 0 % inspection as opposed to 100 % inspection for this product? **[2+4=6]**

Q.5 Two different hardening processes viz. saltwater quenching and oil quenching, are used on samples of a particular alloy. The results of hardness values (using suitable scale) are shown in **Table-1**. Assume that the hardness is normally distributed.

Test the hypothesis that there is no significant difference in the two methods of quenching (on the hardness). Clearly show the test statistics and rejection region on a normal distribution plot. Use 5% level of significance and assume equal variances. **[6]**

Table-1: Hardness data for Q.5

Salt water Quenching	145	150	153	148	141	152	146	154	139	148
Oil Quenching	152	150	147	155	140	146	158	152	151	143

Q.6 Consider a process of extrusion used to make *Aluminum* pipes. For a certain application, the process is in control if the inside diameter of the pipe has a mean of 75 mm with a standard deviation of 0.6 mm. To check whether the process actually is in control, a random sample size of 30 is tested each day.

i) If the control limits are placed at 3 standard deviation, what is the probability of Type-I error? How will you interpret the same in terms of the present application?

ii) If the process mean shifts to 75.2 mm, what is the probability of Type-II error on the first sample tested after this shift? How will you interpret the same in terms of the present application? (Note: Maintain accuracy up to 4 decimal points) **[4+4=8]**