**Birla Institute of Technology & Science, Pilani**
**First Semester 2023-24 (Comprehensive Examination - Regular)**

**ME F443 (QCAR)** **Total Marks 40**
**Date: 13/12/2023** **Total Duration 3hrs**

**SECTION A** **(CLOSE BOOK)** **1 Hour**

**Agree or Disagree with statements given below with proper justification** **[1 mark each]**

Q1. Zero Inspection is the place where acceptance sampling scheme is implemented.

Q2. Average outgoing quality(AOQ) term is used during conventional sampling plan.

Q3. Audit process is an important activity for quality assurance program

Q4. For quality characteristics following Log-normal distribution, the conventional formulae for interval estimate can be used.

Q5. The rational subgrouping of samples is used only for implementation of attribute control charts in a process.

Q6. In variable control chart smaller sample size is used compared to implementation of attribute control chart. Thus variable control chart will be less costly to implement.

Q7. For a six sigma process the Cp value is less than 1. Thus the percentage defective in the process is 0.001 ppm.

Q8. For computation of Cpm, process mean and standard deviation information is required.

Q9. Moving Range chart is used in a processes where sample size is more than 2.

Q10. In scenarios where sample size (n) varies, conventional Xbar-R chart and p -chart will perform best.

Q11. The u- chart categorizes the defects into various types and weighted measure is used to indicate the process is under statically control or not.

Q12. Quality Circles are teams led by the leaders of the organizations.

Q13. Gage Reproducibility study indicate how good the measuring instrument is?

Q14. Hazard/failure rate function is same as reliability measure for the life time study of any products.

Q15. Kano model is most widely used during process design.

Q16. (Bonus) High cost of a product or process is indication of High Quality.

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**SECTION B** **(OPEN BOOK)** **2 Hour**

Q1.
A process manufacturing metal washer is supposed to be operating with a mean diameter, $\mu$ of 1.250 inch and a standard deviation $\sigma$ of 0.002 inch. A random sample of 25 pieces was taken from washers made by the process with sample mean $\bar{x} = 1.256$, in $s = 0.003$ in. In this case test the following hypothesis with producer's risk of 5%.

(i) $H_0 : \sigma = 0.002, H_a : \sigma > 0.002$

(ii) $H_0 : \mu = 1.25. H_a : \mu \neq 1.25$

(iii) Determine the interval estimate for both and state the important findings.

(iv) Another machine was also making these washers. A sample of twenty washers was selected from the second machine with the following result $\bar{x} = 1.23$, $s = 0.0025$ in. Test hypothesis to prove that the variance of two machines are equal and alike by testing their means.

(v) If the requirements for the washers are 1.250±0.010 in, estimate the fraction of nonconforming for the two machines. [1+1+2+2+2]

Q2.
The amount of a preservative added to dairy products should not exceed certain levels of 25 ± *3* mg (set by the Food and Drug Administration). Samples of size 10 of processed cheese produced the values of the average and standard deviation (s) shown in Table1.
(a) Construct appropriate control charts and determine the stability of the process.
(b) If the process is out of control, assuming remedial actions will be taken, estimate the new process mean and standard deviation.
(c) Assuming normality and a target value of 24.5 mg, determine the indices *Cp, Cpk, and Cpm*
(d) What proportion of the dairy products meets government standards, assuming normality?
(e) If it was observed that the process is shifted to 24 mg then what is the probability that the chart will detect the shift by the third sample. [1+1+2+2+2]

Table1

| Obs. | Average Level of Preservative (mg) | Standard deviation (s) | Obs. | Average Level of Preservative (mg) | Standard deviation (s) |
|---|---|---|---|---|---|
| 1 | 22.3 | 5.1 | 8 | 22.6 | 7.4 |
| 2 | 26.3 | 4.3 | 9 | 23.8 | 5.5 |
| 3 | 26.5 | 6.2 | 10 | 24.9 | 8.4 |
| 4 | 24.2 | 7.3 | 11 | 25.3 | 6.2 |
| 5 | 22.1 | 3.6 | 12 | 23.4 | 8.1 |
| 6 | 24.5 | 5.4 | 13 | 20.3 | 5.4 |
| 7 | 29.6 | 7.5 | 15 | 22.4 | 4.3 |

Q3.

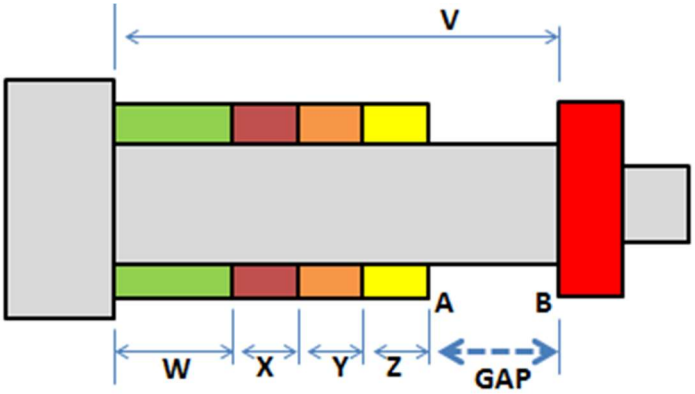
The number of nonconforming parts in a sample of 50 units is observed over a period of several days. Table 2 shows the inspected and the number of imperfections for 20 samples. Construct a suitable control chart. Revise the parameters if necessary, assuming special causes for the out-of-control points. [3]

Table 2

| Sample no | No of units Inspected | Nonconforming units | Sample no | No. of units Inspected | Nonconforming Units |
|---|---|---|---|---|---|
| 1 | 150 | 6 | 11 | 300 | 8 |
| 2 | 100 | 8 | 12 | 300 | 12 |
| 3 | 200 | 5 | 13 | 200 | 6 |
| 4 | 150 | 4 | 14 | 150 | 4 |
| 5 | 250 | 10 | 15 | 200 | 7 |
| 6 | 100 | 11 | 16 | 150 | 14 |
| 7 | 150 | 3 | 17 | 100 | 4 |
| 8 | 200 | 5 | 18 | 100 | 8 |
| 9 | 300 | 10 | 19 | 200 | 9 |
| 10 | 250 | 10 | 20 | 300 | 12 |

Q4.

Given the assembly sketch in Fig. 1 of five parts whose manufacture is believed to be independent and for which random selection is made for the assembly, determine the minimum tolerance that might safely be set on the indicated gap dimension, assuming further that the parts might just meet their respective tolerances. [3]




| Part | Mean Length (cm) | Tolerance (cm) |
|---|---|---|
| **V** | 15 | 15±0.5 |
| **W** | 6 | 6±0.3 |
| **X** | 3 | 3±0.2 |
| **Y** | 2 | 2±0.5 |
| **Z** | 2 | 2±0.4 |

Q5.

In a factory stream of lots arrives at the receiving inspection department. The management decided to use the single sampling plan for lot sentencing. Determine the probability of acceptance Pa, of a lot with sample size n =75 with acceptance number 2 and incoming lot quality is 1.3% nonconforming. Determine the AOQ , ATI if lot size is 10,000? [3]

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