**[Total No. of Questions - 9]** **[Total No. of Printed Pages - 4]**
**(2125)**

**15286**

**B. Tech 7th Semester Examination**

**Total Quality Control (NS)**

**ME-411(e)/AU-411(e)**

**Time : 3 Hours** **Max. Marks : 100**

*The candidates shall limit their answers precisely within the answer-book (40 pages) issued to them and no supplementary/continuation sheet will be issued.*

**Note :** Attempt Five questions in all, selecting one question from each sections A, B, C and D. Section E is compulsory.

**SECTION - A**

1. (a) Define and Differentiate among (i) quality of design QoD, (ii) quality of conformance QoC and (iii) quality of performance QoP (iv) quality of Inspection QoI. What are the elements of QoD, QoC, QoP and QoI? Explain their importance in machine tool industry.

   (b) Customers arrive at a department store, randomly and independently.
   - (i) What is an appropriate distribution for modeling the number of customers that arrive in a 2-hour period?
   - (ii) Under what situations might the stated assumptions not hold?
   - (iii) What information would you need to collect to estimate the probability distribution?
   - (iv) Suppose that a new location is being contemplated for the store. Explain how you would estimate the probability distribution.

   (c) State the importance of probability distributions in quality control. (8+8+4=20)

2. (a) Define Quality Costs. Also, discuss the indices for measuring quality costs. Give examples where each might be used. (10)

   (b) Based on historical data, it is estimated that 12% of new products will obtain a profitable market share. However, if two products are newly introduced in the same year, there is only a 5% chance of both products becoming profitable. A company is planning to market two new products, 1 and 2, this coming year. What is the probability of:
   - (i) only product 1 becoming profitable?
   - (ii) only product 2 becoming profitable?
   - (iii) at least one of the products becoming profitable?
   - (iv) neither product becoming profitable?
   - (v) either product 1 or product 2 (but not both) becoming profitable?
   - (vi) product 2 becoming profitable if product 1 is found to be profitable? (10)

**[P.T.O.]**



**SECTION - B**

3. (a) Discuss the preliminary decisions that must be made before you construct control chart. What concepts should be followed when selecting rational samples?

   (b) Discuss the relationship between ARL and type I and II errors.

   (c) What are warning limits, and what purpose do they serve?

   (d) What is the utility of the operating characteristic curve? How can the discriminatory power of the curve be improved? (4x5=20)

4. A soft drink bottling company is interested in controlling its filling operation. Random samples of size 4 are selected and the fill weight is recorded. Table below shows the data for 24 samples. The specifications on fill weight are 350 ± 5 grams (g). Daily production rate is 20,000 bottles.

   (a) Find the trial control limits for the X- and R-charts.

   (b) Assuming special causes for out-of-control points, find the revised control limits.

   (c) Assuming the distribution of fill weights to be normal, how many bottles are nonconforming daily?

   (d) If the process average shifts to 342 g, what is the probability of detecting it on the next sample drawn after the shift?

   (e) What proportion of the output is nonconforming at the level of process average indicated in part (d)?

| Sample | Observations (g) | | | | Sample | Observations (g) | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 352 | 348 | 350 | 351 | 13 | 352 | 350 | 351 | 348 |
| 2 | 351 | 352 | 351 | 350 | 14 | 356 | 351 | 349 | 352 |
| 3 | 351 | 346 | 342 | 350 | 15 | 353 | 348 | 351 | 350 |
| 4 | 349 | 353 | 352 | 352 | 16 | 353 | 354 | 350 | 352 |
| 5 | 351 | 350 | 351 | 351 | 17 | 351 | 348 | 347 | 348 |
| 6 | 353 | 351 | 346 | 346 | 18 | 353 | 352 | 346 | 352 |
| 7 | 348 | 344 | 350 | 347 | 19 | 346 | 348 | 347 | 349 |
| 8 | 350 | 349 | 351 | 346 | 20 | 351 | 348 | 347 | 346 |
| 9 | 344 | 345 | 346 | 349 | 21 | 348 | 352 | 351 | 352 |
| 10 | 349 | 350 | 352 | 352 | 22 | 356 | 351 | 350 | 350 |
| 11 | 353 | 352 | 354 | 356 | 23 | 352 | 348 | 347 | 349 |
| 12 | 348 | 353 | 346 | 351 | 24 | 348 | 353 | 351 | 352 |

(20)

**SECTION - C**

5. (a) What are some reasons for a process to go out of control due to a sudden shift in the level? Discuss the appropriate setting for using a modified control chart and trend control chart. Compare and contrast the two charts. (10)

(b) Describe the role of the average run length (ARL) in the selection of control chart parameters. Explain how ARL influences sample size. (10)

6. In an injection molding process, the die wears out gradually. To account for this wear, it is suggested that a trend chart be constructed for the outside diameter of the component produced. Samples of size 5 are selected and the sample average X and range R are found. The results of 20 such samples are shown in Table below.

| Sample | Sample Average, $\bar{x}$ (mm) | Sample Range, R (mm) | Sample | Sample Average, $\bar{x}$ (mm) | Sample Range, R (mm) |
|---|---|---|---|---|---|
| 1 | 107.6 | 3.1 | 11 | 111.6 | 2.3 |
| 2 | 104.3 | 2.6 | 12 | 113.3 | 2.5 |
| 3 | 103.5 | 2.8 | 13 | 109.8 | 2.4 |
| 4 | 105.7 | 2.4 | 14 | 110.3 | 2.1 |
| 5 | 104.8 | 3.2 | 15 | 108.6 | 2.6 |
| 6 | 108.5 | 2.5 | 16 | 112.7 | 1.8 |
| 7 | 109.7 | 2.8 | 17 | 114.2 | 2.8 |
| 8 | 105.3 | 1.7 | 18 | 115.5 | 3.0 |
| 9 | 112.6 | 2.4 | 19 | 112.8 | 2.7 |
| 10 | 110.5 | 2.0 | 20 | 116.2 | 2.2 |

Construct the centerline and control limits of a trend chart for the sample average. Is the process in control? If the process is out of control, assume special causes, and revise the limits. Suppose that the specification limits are 110 ± 8 mm. At what point should the die be changed? (20)

## SECTION - D

7. (a) Is it possible for a process to be in control and still produce nonconforming output? Explain. What are the advantages of control charts for attributes over those for variables?

(b) Discuss the assumptions that must be satisfied to justify using a p-chart. How are they different from the assumptions required for a c-chart?

(c) Discuss the procedure for computing average length for a p chart. (8+6+6=20)

8. (a) Explain the salient features of following type of attribute control chart p, np, c and u charts.

(b) Nonconformities in automobiles fall into three categories: serious, major, and minor. Twenty-five samples of five automobiles are chosen, and the total number of nonconformities in each category is reported. Table below shows the results. Assuming a weighing system of 50, 10, and 1 for serious, major, and minor nonconformities, respectively, construct demerits per unit control chart. Revise the control limits if necessary, assuming special causes for points that are out of control.

**[P.T.O.]**



| Sample | Serious Defects | Major Defects | Minor Defects | Sample | Serious Defects | Major Defects | Minor Defects |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 5 | 8 | 14 | 0 | 7 | 12 |
| 2 | 0 | 3 | 2 | 15 | 0 | 2 | 8 |
| 3 | 1 | 0 | 6 | 16 | 0 | 4 | 3 |
| 4 | 1 | 2 | 1 | 17 | 1 | 0 | 5 |
| 5 | 0 | 6 | 8 | 18 | 0 | 3 | 2 |
| 6 | 0 | 3 | 3 | 19 | 0 | 5 | 8 |
| 7 | 0 | 1 | 10 | 20 | 0 | 2 | 6 |
| 8 | 1 | 2 | 5 | 21 | 1 | 1 | 4 |
| 9 | 0 | 4 | 9 | 22 | 0 | 3 | 10 |
| 10 | 2 | 6 | 6 | 23 | 0 | 2 | 12 |
| 11 | 1 | 3 | 2 | 24 | 0 | 4 | 7 |
| 12 | 0 | 5 | 8 | 25 | 0 | 2 | 4 |
| 13 | 0 | 0 | 9 | | | | |

(8+12=20)

## SECTION - E

9. (a) Define Statistical Quality control. State its advantages in Industry.

(b) Which type of control chart (p-, np-, c-, u-, U-, or charts for highly conforming processes) is most appropriate to monitor the following situations?

(i) Number of potholes in highways

ii) Control of the wiring and transistor defects in an electronic component (wiring defects are considered more serious)

(c) How average run length for X chart is computed?

(d) Define efficiency of control chart. How it can be measured?

(e) Define control charts for number of defects. What are their relative merits and demerits?

(f) Define Type-I and Type -II errors and what are the methods to reduce them?

(g) Discuss the significance of an appropriate sample size for a proportion-nonconforming chart.

(h) Explain the conditions under which a U-chart would be used instead of a C-chart.

(i) State importance of Normal and Poisson distribution in SQC.

(j) A process in control has an estimated standard deviation of 3 mm. The specification limits for the corresponding product are 100 ± 7 mm. Estimate the capability ratio of the process. (10×2=20)