

ORDRE DES INGÉNIEURS DU QUÉBEC

NOVEMBER 2018 SESSION

Open-book examination

Non-programmable calculators: only authorized models

Duration: 3 hours

14-IN-A5 Quality planning, control and assurance

QUESTION #1 (10 points)

Distinguish among quality planning, quality assurance, and quality control and improvement.

QUESTION #2 (10 points)

A production process operates with 1% nonconforming output. Every hour a sample of 25 units of product is taken, and the number of nonconforming units counted. If one or more nonconforming units are found, the process is stopped and the quality control technician must search for the cause of nonconforming production.

- a) What is the probability that the samples will have one or more nonconforming units (5 pts)
- b) Evaluate the performance of this decision rule (5 pts)

QUESTION #3 (10 points)

A lot of size $N = 30$ contains three nonconforming units.

- a) What is the probability that a sample of 10 units selected at random contains exactly one non-conforming unit? (5 pts)
- b) What is the probability that it contains two or more non-conforming units? (5 pts)

QUESTION #4 (15 points)

MIL STD 105E is being used to inspect incoming lots of size $N = 12\,000$. Single sampling, general inspection level II and an AQL of 1.5% are being used.

- a) Find the normal, tightened, and reduced inspection plans. (9 pts)
- b) Suppose that sampling procedure terminates with neither acceptance nor rejection criteria having been met under reduced inspection, explain what would you decide? (6 pts)

QUESTION #5 (25 points)

Parts manufactured by an injection molding process are subjected to a compressive strength test. Twenty samples of five parts each are collected, and the compressive strengths (in psi) are shown in Table 1.

Table 1: Strength data

Sample Number	x_1	x_2	x_3	x_4	x_5	\bar{x}	R
1	83.0	81.2	78.7	75.7	77.0	79.1	7.3
2	88.6	78.3	78.8	71.0	84.2	80.2	17.6
3	85.7	75.8	84.3	75.2	81.0	80.4	10.4
4	80.8	74.4	82.5	74.1	75.7	77.5	8.4
5	83.4	78.4	82.6	78.2	78.9	80.3	5.2
6	75.3	79.9	87.3	89.7	81.8	82.8	14.5
7	74.5	78.0	80.8	73.4	79.7	77.3	7.4
8	79.2	84.4	81.5	86.0	74.5	81.1	11.4
9	80.5	86.2	76.2	64.1	80.2	81.4	9.9
10	75.7	75.2	71.1	82.1	74.3	75.7	10.9
11	80.0	81.5	78.4	73.8	78.1	78.4	7.7
12	80.6	81.8	79.3	73.8	81.7	79.4	8.0
13	82.7	81.3	79.1	82.0	79.5	80.9	3.6
14	79.2	74.9	78.6	77.7	75.3	77.1	4.3
15	85.5	82.1	82.8	73.4	71.7	79.1	13.8
16	78.8	79.6	80.2	79.1	80.8	79.7	2.0
17	82.1	78.2	75.5	78.2	82.1	79.2	6.6
18	84.5	76.9	83.5	81.2	79.2	81.1	7.6
19	79.0	77.8	81.2	84.4	81.6	80.8	6.6
20	84.5	73.1	78.6	78.7	80.6	79.1	11.4

- Set-up \bar{X} and R charts on the process. Is the process in statistical control? (10 pts)
- Estimate the process standard deviation using the range method? (2 pts)
- If specifications are 80 ± 5 , find the percentage of nonconforming parts produced by this process. (4 pts)
- Calculate C_p and C_{pk} . (5 pts)
- Interpret these capability ratios. (4 pts)

QUESTION #6 (10 points)

The number of nonconformities found on final inspection of a tape deck is shown in Table 2.

Table 2: Inspection data

Deck number	Number of nonconformities	Deck number	Number of nonconformities
2412	0	2421	1
2413	1	2422	0
2414	1	2423	3
2415	0	2424	2
2416	2	2425	5
2417	1	2426	1
2418	1	2427	2
2419	3	2428	1
2420	2	2429	1

- a) Compute control limits for the appropriate control chart? (6 pts)
- b) Is the process in statistical control? (2 pts)
- c) What center line and control limits would you recommend for controlling future production? (2 pts)

QUESTION #7 (20 points)

The commercial loan operation of a financial institution has a standard for processing new loan applications in 24 hours. Table 3 shows the number of applications processed each day for the last 20 days and the number of applications that required more than 24 hours to complete.

Table 3: Loan application data

Day	Number of applications	Number late	Day	Number of applications	Number late
1	200	3	11	219	0
2	250	4	12	238	10
3	240	2	13	250	4
4	300	5	14	302	6
5	200	2	15	219	20
6	250	4	16	246	3
7	246	3	17	251	6
8	258	5	18	273	7
9	275	2	19	245	3
10	274	1	20	260	1

- Set up the appropriate control chart for this process. Is the process in statistical control? (10 pts)
- Assume that assignable causes can be found for any out-of-control points on this chart. What center line should be used for process monitoring in the next period, and how should the control limits be calculated? (10 pts)