

ORDRE DES INGÉNIEURS DU QUÉBEC

NOVEMBER 2017 SESSION

Open-book examination
Calculators : only authorized models
Duration : 3 hours

Examen 14-IN-A5 QUALITY PLANNING, CONTROL AND ASSURANCE

QUESTION 1 (20 Points) :

The number of nonconforming switches in samples of size 150 are shown in the Table below. Construct a fraction nonconforming control chart for these data. Does the process appear to be in control? If not, assume that assignable causes can be found for all points outside the control limits and calculate the revised control limits.

Number of Nonconforming Switches

Sample Number	Number of Nonconforming Switches	Sample Number	Number of Nonconforming Switches
1	8	11	6
2	1	12	0
3	3	13	4
4	0	14	0
5	2	15	3
6	4	16	1
7	0	17	15
8	1	18	2
9	10	19	3
10	6	20	0

QUESTION 2 (20 Points) :

A high-voltage power supply should have a nominal output voltage of 350 V. A sample of four units is selected each day and tested for process-control purposes. The data shown in the table below give the difference between the observed reading on each unit and the nominal voltage times ten; that is, $x_i = (\text{observed voltage on unit } i - 350) * 10$

- a) Set up an \bar{X} bar and R charts on this process. Is the process in statistical control?
- b) If specifications are at 350 V + or - five V, what can you say about process capability?
- c) Is there evidence to support the claim that voltage is normally distributed?

Voltage Data

Sample Number	x_1	x_2	x_3	x_4
1	6	9	10	15
2	10	4	6	11
3	7	8	10	5
4	8	9	6	13
5	9	10	7	13
6	12	11	10	10
7	16	10	8	9
8	7	5	10	4
9	9	7	8	12
10	15	16	10	13
11	8	12	14	16
12	6	13	9	11
13	16	9	13	15
14	7	13	10	12
15	11	7	10	16
16	15	10	11	14
17	9	8	12	10
18	15	7	10	11
19	8	6	9	12
20	13	14	11	15

QUESTION (20 Points) 3 :

The uniformity of a silicon wafer following an etching process is determined by measuring the layer thickness at several locations and expressing uniformity as the range of the thicknesses. The table below presents uniformity determinations for 30 consecutive wagers processed through the etching tool.

- a) Construct a control chart for individuals and a moving range control chart for uniformity for the etching process. Is the process in statistical control?

Uniformity Data

Wafer	Uniformity	Wafer	Uniformity
1	11	16	15
2	16	17	16
3	22	18	12
4	14	19	11
5	14	20	18
6	22	21	14
7	13	22	13
8	11	23	18
9	6	24	12
10	11	25	13
11	11	26	12
12	23	27	15
13	14	28	21
14	12	29	21
15	7	30	14

QUESTION 4 (20 Points) :

A supplier ships a product in lots of size $N = 8000$. We wish to have an AOQL of 3 %, and we are going to use single sampling. We do not know the supplier's process fail out but suspect that it is at most 1 % defective.

- a) Find the appropriate Dodge-Romig plan.
- b) Find the ATI (Average Total Inspection) for this plan, assuming that incoming lots are 1 % defective.
- c) Suppose that our estimate of the supplier's process average is incorrect and that it is really 0.25 % defective. What sampling plan should we have used?

QUESTION 5 (10 Points):

A product is supplied in lots of size $N = 10,000$. The AQL has been specified at 0.10 %. Find the normal, tightened, and reduced single-sampling plans from MIL STD 105^E, assuming general inspection level II.

QUESTION 6 (10 Points):

Please comment on the following subjects:

- Six-Sigma
- Design for Six-Sigma
- Continuous Improvement
- Seven Basic Tool of Quality