

ORDRE DES INGÉNIEURS DU QUÉBEC

November 2015 SESSION

Open-book examination

Non-programmable calculators: only authorized models

Duration: 3 hours

**14-IN-A5 Quality planning, control and assurance**

**QUESTION #1 (12 points)**

- a) Explain briefly each step of the DMAIC process. (6 pts)
- b) Why are designed experiments most useful in the improve step of DMAIC? (6 pts)

**QUESTION #2 (12 points)**

A mechatronic assembly is subjected to a final functional test. Suppose that defects occur at random in these assemblies, and that the occurrence rate of defects is 0.02.

- a) What is the probability that an assembly will have exactly one defect? (6 pts)
- b) What is the probability that two assemblies will have one or more defects? (6 pts)

**QUESTION #3 (12 points)**

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

- a) What is the probability that a sample of 5 units selected at random contains exactly one non-conforming unit? (6 pts)
- b) What is the probability that it contains one or more nonconformances? (6 pts)

**QUESTION #4 (12 points)**

MIL STD 105E is being used to inspect incoming lots of size  $N = 5000$ . Single sampling, general inspection level II and an AQL of 0.65% are being used.

- a) Find the normal, tightened, and reduced inspection plans. (6 pts)
- b) Suppose that incoming lots are 5% nonconforming. What is the probability of rejecting these lots under normal inspection? (6 pts)

**QUESTION #5 (20 points)**

The data shown in Table 1 are the deviations from nominal diameter for holes drilled in a carbon-fiber composite material used in aerospace manufacturing. The values reported are deviations from nominal in ten-thousandths of an inch.

Table 1: Hole diameter data

Sample number	$x_1$	$x_2$	$x_3$	$x_4$	$x_5$
1	-30	+50	-20	+10	+30
2	0	+50	-60	-20	+30
3	-50	+10	+20	+30	+20
4	-10	-10	+30	-20	+50
5	+20	-40	+50	+20	+10
6	0	0	+40	-40	+20
7	0	0	+20	-20	-10
8	+70	-30	+30	-10	0
9	0	0	+20	-20	+10
10	+10	+20	+30	+10	+50

- a) Set-up  $\bar{X}$  and  $R$  charts on the process. Is the process in statistical control? (12 pts)
- b) Estimate the process standard deviation using the range method? (2 pts)
- c) If specifications are at nominal  $\pm 100$ , find the percentage of nonconforming holes produced by this process. (6 pts)

**QUESTION #6 (14 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 process is in control with  $\bar{\bar{X}} = 351,0375$  and  $\bar{R} = 0,625$ . Specifications are at  $350 \pm 5$  V.

- a) Calculate  $C_p$  and  $C_{pk}$ . (8 pts)
- b) Interpret these capability ratios. (6 pts)

**QUESTION #7 (18 points)**

A process produces rubber belts in lots of size 2500. Inspection records on the last 20 lots reveal the data in Table 2.

Table 2: Inspection data

Lot number	Number of nonconforming belts	Lot number	Number of nonconforming belts
1	230	11	456
2	435	12	394
3	221	13	285
4	346	14	331
5	230	15	198
6	327	16	414
7	285	17	131
8	311	18	269
9	342	19	221
10	308	20	407

- Compute trial control limits for the appropriate control chart? Is the process in statistical control? (12 pts)
- If you wanted to set-up a control chart for controlling future production, how would you use these data to obtain the center line and control limits for the chart? (6 pts)