IME 302 Introduction to Quality Engineering – ~~Summer 2011~~, ksk

EXAM 2 (Includes Chapters 3, 4 & 6)

1. Talking about designing a customer survey instrument, one way to evaluate its reliability (dependability) is to:
   1. Find the proportion of people who answer all questions
   2. Give the questionnaire to the same set of people twice and evaluate the correlation between the responses
   3. Ask each question in two different ways and take the difference of the two responses
   4. Find the correlation between the number of people who responded and the number of right answers
   5. All of the above

   (2)

2. Suppose we want to determine the sample size for a survey that requires expression of the customer preference on the 1-to-5 scale. Suppose also that the confidence level needed is 90%; the estimate for standard deviation of the scores from previous, similar survey is 0.5; and the allowable error is +/- 0.1. Find the sample size needed.
   1. 96
   2. 68
   3. 112
   4. 231
   5. 44

   $n = \left(\frac{z_{\alpha/2} \times s}{e}\right)^2$ $\alpha = 0.1 \Rightarrow z_{\alpha/2} = z_{0.05} = 1.645$

   $= \left(\frac{1.645 \times 0.5}{0.1}\right)^2 = 67.7 \simeq 68$ (2)

3. One of the major functions of the House of Quality is to:
   1. Prioritize the chosen product features with regards to how they respond to customer requirements
   2. Prioritize all the competitors of a product with regards to how much they cost
   3. Choose target prices for the product so that the proposed product will sell well
   4. Choose products such that they will be accepted in all households in all ranges of income levels
   5. Choose product name such that it will become a household name

   (1)

4. The feature of the QFD method that allows comparison of the proposed product features with those of the best among the competitors has a special name:
   1. comparison of the competitor
   2. competitionizing
   3. benchmarking
   4. marketability
   5. MVP pricing

   (3)

5-7. The results from a 2^2 design are shown below for two replicates. The response is surface finish measurements from machining, and, the smaller the value the better is the response. Calculate the effect of B

Treat.. Comb. code	Design columns		Calculation column	Response (min.)		
	Factor A (Tool size)	Factor B (Speed)	Interaction (AB)	Repl1	Repl2	Ave
(1)	−	−	+	18	14	16
a	+	−	−	24	22	23
b	−	+	−	14	16	15
ab	+	+	+	40	36	38

$B = -\frac{16 - 23 + 15 + 38}{2} = 27$ 7 (--------)

8-10. The results from a 2^3 design are shown below for two replicates. The response is surface finish measurements from machining, and, the smaller the value the better is the response. Calculate the effect of BC.

Treat. Comb.	Design columns: Factor A (Speed)	Factor B (Shape)	Factor C (Angle)	Calculation columns: Int. AB	Int. AC	Int. BC	Int. ABC	Repl. 1	Repl. 2	Ave.
(1)	−	−	−			+		22	31	26.5
a	+	−	−			+		32	42	37
b	−	+	−			−		35	34	34.5
ab	+	+	−			−		55	47	51
c	−	−	+			−		44	45	44.5
ac	+	−	+			−		60	40	50
bc	−	+	+			+		40	37	38.5
abc	+	+	+			+		39	41	40

$BC = \frac{26.5 + 37 - 34.5 - 51 - 44.5 - 50 + 38.5 + 40}{4} = -9.5$

-9.5 (-------)

11. The results from a 2^2 design are shown above in Problem #5-7, for two replicates. The response is surface finish measurements from machining, and the smaller the value the better is the response. Calculate an estimate for the experimental error S^2 and set a 95% C.I. for the effect of B.

$S^2 = \frac{1}{4}\left[(18-16)^2 + (16-14)^2 + (24-23)^2 + (23-22)^2 + (15-14)^2 + (16-15)^2 + (40-38)^2 + (38-36)^2\right] = 5$

$SE = \sqrt{5/2} = 1.58$. 95% CI for $B = 7 \pm 2(1.58) =$ $3.84, 10.16$ (-------,-------)

12. A track for a track type tractor is made up of 121 links, each link being produced independently with a nominal length of 10". If the tolerance on the total length should not be more than ±4.4", what should be the maximum tolerance on the links?

1. ± 0.2"
2. ± 0.3"
3. ± 0.4"
4. ± 0.036"
5. ± 0.046"

Let t be the tolerance on the links.

Tolerance on the track $= \sqrt{121 \times t^2} = 4.4$

$11t = 4.4$

$t = 0.4$

(3)

13. A track for a track-type tractor is made up of 144 links, each link being produced independently with a nominal length of 10". If the tolerance on the links is ± 0.12" then the tolerance on the track =

1. ± 18.0"
2. ± 1.80"
3. ± 14.4"
4. ± 1.44"
5. ± 0.125"

Tolerance on the track $= \pm\sqrt{144 \times 0.12^2} = 12 \times 0.12 = 1.44$

(4)

14. A sample of 100 measurements taken from a process gave sample standard deviation $s = 1.0$. The product has spec limits at 8.0 and at 11.0. Calculate the value of Cp. Assume process is normal.

1. 0.250
2. 0.243
3. 0.167
4. 0.500
5. 1.000

$C_p = \frac{11-8}{6 \times 1.0} = 0.5$

(4)

15. A sample of 100 measurements taken from a process gave sample standard deviation $s = 1.33$. The product has spec limits at 8.0 and at 11.0. Calculate the value of Cpk if process average = 10.0?

1. 0.250
2. 0.243
3. 0.167
4. 0.500
5. 1.000

$C_{pk} = \frac{\text{Min.}[(11-10),(10-8)]}{3 \times 1.33} = \frac{1}{4} = 0.25$

(1)

16. *X*-bar and *R* control charts were prepared for a process using 20 subgroups with 5 units in each subgroup. *X*-double bar was 33.6 and *R*-bar was 6.2. Find the lower and upper (3-sigma) Control Limits for *X*-bar.

1. 6.2, 33.6
2. 27.4, 39.8
3. 30.02, 37.17
4. 15.0, 5.2
5. Cannot be calculated

$UCL(\bar{X}) = \bar{\bar{X}} + A_2\bar{R} = 33.6 + 0.577(6.2) = 37.17$

$LCL(\bar{X}) = \bar{\bar{X}} - A_2\bar{R} = 33.6 - 0.577(6.2) = 30.02$

(3)

17. *X*-bar and *R* control charts were prepared for a process using 30 subgroups with 5 units in each subgroup. *X*-double bar was 33.6 and *R*-bar was 6.2. Find the lower and upper (3-sigma) control limits for the *R*-chart:

1. 0.0, 13.11
2. 6.2, 13.11
3. 6.2, 18.6
4. 0.0, 18.6
5. not enough information

$UCL(R) = D_4\bar{R} = 2.114(6.2) = 13.11$

$LCL(R) = D_3\bar{R} = 0(6.2) = 0$

(1)

18. *X*-bar and *R* control charts were prepared for a process using 30 subgroups with 5 units in each subgroup. *X*-double bar was 33.6 and *R*-bar was 6.2. During production, a sample of 5 pieces was taken from this process and the pieces measured 36, 43, 37, 34 and 38. We conclude:

1. Both average and range were within limits
2. Neither average nor range was within limits
3. Only average was outside limits
4. Only range was outside limits
5. Can't say anything

From sample:

$\bar{X} = 37.6$

$R = 43 - 34 = 9$

Compare w/ limits calculated in problems 16 & 17.

(3)

19. *X*-bar and *R* control charts were prepared for a process using 20 subgroups with 5 units in each subgroup. *X*-double bar was 33.6 and *R*-bar was 6.2. If the process is to be controlled with a given target at 35, the limits for the (3-sigma) *R*-chart would be:

1. 0.0, 13.11
2. 4.2, 13.11
3. 4.2, 18.6
4. 0.0, 18.6
5. cannot be calculated

The limits for the R-chart does not change when the target is given.

(1)

20. Quality of insulation on electrical cable is controlled by checking the number of pinholes per foot of cable. If cable size varies in width, i.e., one chart is used for several cable sizes, the control chart to use:

1. *X*-bar chart
2. *R*-chart
3. *P*-chart
4. *C*-chart
5. *U*-chart

(5)

21. A process that produces fuses is controlled by finding the proportion defective fuses in each sample (of about 100 units) at regular time intervals. The type of control chart appropriate for this situation is:

1. *X*-bar chart
2. *R*-chart
3. *P*-chart
4. *C*-chart
5. *U*-chart

(3)

22. A *C*-chart is used with *c*-bar = 2.0. The *LCL* & *UCL* for 3-sigma-limits would be:

1. 0.0, 2.0
2. 2.0, 6.0
3. 0.0, 6.242
4. 0.586, 3.414
5. 1.237, 4.896

$UCL(c) = \bar{c} + 3\sqrt{\bar{c}} = 2.0 + 3(\sqrt{2.0}) =$

$LCL(c) = \bar{c} - 3\sqrt{\bar{c}} = 2.0 - 3(\sqrt{2.0})$

(3)

23. *X*-bar and *S* control charts are maintained to control the diameter of a punched hole. After 30 subgroups of 12 units each were taken, the results showed: Sum of the 30 *X*-bars = 7.6173 and Sum of the 30 *S*'s = 0.067. The upper and lower control limits for the (3-sigma) *X*-bar chart:

1. 0.2519, 0.2559
2. 0.5876, 0.7653
3. 0.2516, 0.2592
4. 0.2152, 0.3936
5. 0.1252, 0.2926

$\bar{\bar{X}} = \frac{7.6173}{30} = 0.25391$ $\quad \bar{S} = \frac{0.067}{30} = 0.00233$

$UCL(\bar{\bar{X}}) = \bar{\bar{x}} + A_3\bar{S}$

$LCL(\bar{\bar{X}}) = \bar{\bar{x}} - A_3\bar{S}$

$= 0.25391 \pm 0.886(0.00223$

(1)

24. In an *X*-bar chart, the false alarm means:

1. The process is in control but the control chart says it is not in control
2. The process is not in control but the control chart says it is in control
3. The process is in control and the control chart says it is in control
4. The process is not in control and the control chart says it is not in control
5. All of the above

(1)

25. An *X*-bar chart has 3-sigma control limits. If the process can be assumed to be normally distributed the probability of a false alarm:

1. 0.01242
2. 0.00135
3. 0.00270
4. 0.04560
5. 0.00046

(3)

26. A process is in control as shown by the *X*-bar chart and *R*-chart with centerline of *X*-bar chart = 54.27 and centerline of *R*-chart = 4.07. An estimate for the standard deviation of the process σ=: (*n*=5).

1. 4.07
2. 5.43
3. 1.75
4. 3.58
5. 2.00

$\hat{\sigma} = \bar{R}/d_2 = \frac{4.07}{2.326} = 1.749$

(3)

27. A process is in control as shown by the X-bar chart and R-chart with centerline of X-bar chart = 54.27 and centerline of R-chart = 4.07. If the process has specification limits at 48 and 56, what is the value of Cp? (n =5).

1. 0.76
2. 1.26
3. 2.12
4. 0.45
5. 1.33

$$C_p = \frac{(56-48)}{6 \times 4.07/2.326} = 0.76$$

(1)

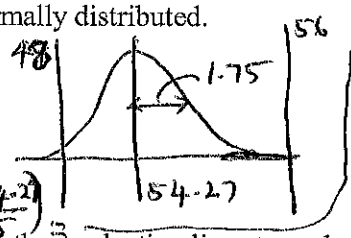
28. A process is in control as shown by the X-bar chart and R-chart with centerline of X-bar chart = 54.27 and centerline of R-chart = 4.07. If the process has specification limits at 48 and 56, what percent of the production is outside spec.? Use n = 5. Assume the process is normally distributed.

1. 16.1
2. 3.68
3. 5.92
4. 27.2
5. 3.66

$\hat{\sigma} = \frac{4.07}{2.326} = 1.75$

$P(X>56) + P(X<48)$

$= 1 - \Phi\left(\frac{56-54.27}{1.75}\right) + \Phi\left(\frac{48-54.27}{1.75}\right)$



$= 1 - \Phi(0.99) + \Phi(-3.6) \approx 0$

$= 1 - 0.8389 = 0.1611 = 16.1\%$

(1)

29. Subgroups of 100 vacuum tubes were drawn from the production line at regular intervals. The total number of defective tubes found in 20 successive subgroups (of 100 units each) was 45. The 3-sigma limits for the control chart to control fraction defectives, the P-chart:

1. 0.0, 0.0225
2. –0.022, 0.06699
3. 0.0, 0.06699
4. –0.022, 0.9234
5. 0.0, 0.9234

$$\bar{p} = \frac{45}{20 \times 100} = 0.0225$$

$$UCL\} = 0.0225 \pm 3\sqrt{\frac{(0.0225)(0.9775)}{100}}$$

(3)

30. A control chart on the number of flaws per airplane wing showed excellent control with average number of flaws = 12.0. The 2-sigma control limits for future control for this process would be:

1. 5.07, 18.92
2. 2.76, 16.76
3. 0.00, 12.0
4. 1.61, 22.39
5. Not enough information

Use C-chart

$UCL(c) = \bar{c} + 3\sqrt{\bar{c}} = 12 + 3\sqrt{12} = 22.39$

$LCL(c) = \bar{c} - 3\sqrt{\bar{c}} = 12 - 3\sqrt{12} = 1.61$

(4)

31. The concept of "rational sub-grouping" in preparing a control chart means:

1. Only rational group of people should design control charts.
2. Sub-grouping should be done in a way to provide leads to discovering assignable causes
3. Group technology should be used in manufacturing products so the sub-grouping will be rational
4. No more than 5 items should be taken in a subgroup because that is the rational subgroup size
5. all of the above.

(2)

32. One of the following is a valid recommended rule to use with a control chart to signal the existence of an assignable cause, to be used in addition to the one value outside 3-sigma limit rule.

1. More than 3 plots on the same side of the center line
2. More than 7 plots in a run down or run up
3. More than 5 out of 6 consecutive plots outside 3-sigma line
4. More than 3 out of 4 consecutive plots outside 2-sigma warning lines, on the same side
5. All of the above

(2)

33. A process is controlled by X-bar and S charts with sample size of 4. If the value of S-bar is 4.2, then a (good) estimate for the process standard deviation σ=:

1. 4.2
2. 2.4
3. 2.0
4. 4.6
5. 7.8

$$\hat{\sigma} = \frac{\bar{S}}{c_4} = \frac{4.2}{0.921} \left(= 4.56\right) \approx 4.6$$

(4)

34. One of the advantages of using an X-bar chart rather than the chart for individuals is:
    1. The operators usually like to plot X-bars.
    2. The X-bar chart is the most powerful chart for discovering small changes in a process.
    3. The X-bar chart is known to be robust with respect to normality assumption
    4. The X-bar chart is the least powerful of all charts
    5. None of the above

(3)

35. Pick out the worst match:
    1. Assignable cause - special cause
    2. Limits for future control - limits from "remaining samples"
    3. A process in-control – A capable process
    4. Stable system of chance causes - common causes
    5. False alarm - Type I error

(3)

36. Pick out the true statement in the context of using control charts on processes.
    1. Control limits represent the limits of common cause variability
    2. Process in control does not mean that the process is acceptable
    3. If special causes are indicated by the chart, they should be eliminated
    4. Frequency of sampling can be reduced based on confidence gained in the stability of the process
    5. All of the above

(5)

37. In an R&R study of a thickness gage to measure rubber sheet thickness, an operator measured a sheet twice using the gage and obtained the two readings: 0.64 and 0.72. Another operator used the same gauge and measured the thickness of the same sheet and obtained the readings: 0.84 and 0.72. Then a good estimate for the repeatability error σ_e:
    1. 0.152
    2. 0.105
    3. 0.089
    4. 0.067
    5. 0.133

To get repeatability error.
Range R_1 from operator 1 : $0.72 - 0.64 = 0.08$
R_2 " " 2 : $0.84 - 0.72 = 0.12$.
$\bar{R} = \frac{0.08 + 0.12}{2} = 0.10$ | $\hat{\sigma}_e = \bar{R}/d_2 = \frac{0.10}{1.128} = 0.089$

(3)

These have the same answers. I have to change it problem a bit to get two different answers. I'll do it sometime soon

38. In an R&R study of a thickness gage to measure rubber sheet thickness, an operator measured a sheet twice using the gage and obtained the two readings: 0.64 and 0.72. Another operator used the same gauge and measured the thickness of the same sheet and obtained the readings: 0.84 and 0.72. Then a good estimate for the reproducibility error σ_o:
    1. 0.15
    2. 0.11
    3. 0.09
    4. 0.06
    5. 0.13

To get reproducibility error

$\bar{X}_1 = \frac{0.64 + 0.72}{2} = 0.68$

$\bar{X}_2 = \frac{0.84 + 0.72}{2} = 0.78$

$R_{\bar{X}} = 0.10$

$\hat{\sigma}_o = \frac{R_{\bar{X}}}{d_2} = \frac{0.10}{1.128} = 0.089$

(3)

39. One of the following is not a characteristic of a quality leader
    1. Having a vision for the future
    2. Having high expectations for the organization
    3. Sharing power with others in the organization
    4. Having an eagerness to learn what he/she doesn't know
    5. Lets everybody else do the work for quality

(5)

40. Open communication in a quality organization means:
    1. The company CEO keeps his/her door open all the time
    2. All the company information is accessible to everyone in the organization
    3. Everyone in the company gets a telephone in the workplace
    4. Everyone gets to speak in every company meeting
    5. All of the above

(2)

41. Pick the statement that is true of what happens when employees are empowered:
    1. The employees become more responsible for their work
    2. The employees willingly participate in decision-making
    3. They show commitment to satisfying customer
    4. All of the above
    5. None of the above

(4)

42. Complete the sentence, which is attributed to Dr. Deming: "Competent men in every position, if they are doing their best, know all that there is to know about their work----------."
    1. except how to improve it
    2. except how to make profit
    3. except how to put the finishing touch
    4. except how to package it
    5. except how to do proper maintenance on the machines

(1)

43. In making a strategic plan, the mission statement says----------and the vision statement says ----------.
    1. why the organization exists, where the organization wants to be
    2. where the organization wants to be, why the organization exists
    3. where the organization exists, and why the organization wants to be
    4. where the organization exists, and where the organization wants to relocate
    5. When the organization existed, and when the organization will exist again

(1)

44. One of the following will not be a result of a successful training program
    1. Increase in the number of successful projects completed
    2. Decrease in absenteeism
    3. Increase in volunteers to participate in teams
    4. Increase in satisfied customers
    5. None of the above

(5)

45. One of the following does not belong in the list of criteria on which a team's strength must be evaluated initially when the team is formed and later periodically.
    1. If every one understands the mission of team
    2. If adequate expertise exists within the team for the task on hand
    3. If approximately equal number of women and men are in the team
    4. If all members of the team can work together with trust and honesty
    5. If everyone understands their responsibility

(3)

46. In the context of conducting team meetings the "100-mile rule" means:
    1. Never allow a team member to travel beyond 100 miles while the team is hard at work
    2. Do not choose meeting places beyond 100 mile radius of the work place
    3. Do not include anyone in the team whose regular place of work is beyond 100 miles of the majority of the team.
    4. The team leader should not go anywhere beyond 100 miles driving distance
    5. None of the above

(5)

47. One of the following is true of Quality Circles
    1. The team members always sit in a circle for their meetings
    2. They communicate among themselves using a circular news letter
    3. They are prohibited from using circular arguments in their discussions
    4. The members of the team are volunteers
    5. They only had "mixed" results with them in Japan

(4)

48. The gap-analysis in the context of strategic planning refers to analyzing the difference between:
    1. the highest paid and the lowest paid employee in the organization
    2. the profit expected and profit made in the most recent year
    3. the education qualification of the managers and executives
    4. the salaries of their employees and the employees of their competitors
    5. none of the above

(5)

49. One of the following is an advice that comes from people experienced in statistical process control
    1. The first control chart that you make for a new process should be made with paper and pencil
    2. Never use a computer method unless you fully understand how the computer method works
    3. Believe-every one wants to do a good job if only they have the opportunity and resources to do it
    4. A majority of the problems (85%) relating to quality and process control can be resolved only by management action
    5. All of the above

(5)

50. With regards to training people in statistical methods, Dr. Deming said
    1. No one should teach the theory and use of control charts without knowledge of statistical theory through at least the master's level.
    2. Only those who have at least 15 years of experience in industry should be given training in process control work
    3. Every one including engineers and workers should be trained in design of experiments
    4. Engineers should be trained in engineering and statisticians should be trained in statistics
    5. All of the above

(1)