OMIS 2010 – Fall 2017
Assignment B3

Assignment Instructions (**please read carefully**)

1. Submit your assignment to the link posted on Moodle.
2. Make sure to upload it to the correct link by section.
3. Work can be done by pairs. If you choose to work in a pair, only one person uploads the assignment, adding both names on the file. The file names should be of the form: "Hw1_LastName1_LastName2.xlsx" where LastName1 is the last name of student 1, and LastName2 is the last name of student 2.
4. You are free to discuss your approach with other individuals or pairs, but your write-up should be prepared independently by the person(s) submitting the assignment. It is a violation of the rules of academic honesty to copy someone else's assignment and present it as your own.
5. Optional cover page is posted (see next page).
6. You should upload 2 files:
    a. One file with the answers (Word or PDF). The answer file should include screenshots of supporting work (Excel model & output) to accompany the relevant question.
    b. Excel file with your work [always submit the Excel work to support your answer] Use tabs to identify the answers to each individual question when needed.
7. Generally answers should be typed on the computer (the network diagram can be generated manually and incorporated into the assignment document).
8. Assignments should be organized by question. That means every piece of information for that question is found in the same section of the report. Use labeling and titles to make sure all is clear. If I have to look for it, it is not organized. Don't forget to add the Excel outputs if you used them to analyze the case. You may use an appendix to give further details of your model or calculations if required.
9. Late work will not be accepted. (You will earn a grade of 0.)

OMIS 2010 - Assignment Cover Page
Fall 2017

Schulich School of Business

Assignment #:	B3
Section:	

	Group member 1	Group member 2	Group member 3
Last Name:	Afridi	Khalique	Wu
First Name:	Haseeb	Hamza	Kevin
Student #:	215-011-687	215-075-609	214-764-443

Question 1

At Isogen Pharmaceuticals, the filling process for its asthma inhaler is set to dispense 150 milliliter (ml) of steroid solution per container.
The quality technician is taking 5 containers from the process line every hour to perform the quality check.
Below is the table of his shift on one of the working days:

Time	1	2	3	4	5
7:00am	150	149	149.5	150.5	151
8:00am	151	148	150	150	150.5
9:00am	150	150	150.5	148	151
10:00am	150	150	150	150.5	150.5
11:00am	149	149.5	150	150	151
12:00pm	151	151	150	150.5	151
1:00pm	152	153	150	151	151.5
2:00pm	150	150	150	149.5	149
3:00pm	151	150	150	150	150.5

a) Use the data to construct the appropriate control chart/s to assess if the filling machine is working well. Provide numerical values and chart/s.

Time	1	2	3	4	5	Mean	Range
7am	150	149	149.5	150.5	151	150	2
8am	151	148	150	150	150.5	149.9	3
9am	150	150	150.5	148	151	149.9	3
10am	150	150	150	150.5	150.5	150.2	0.5
11am	149	149.5	150	150	151	149.9	2
12am	151	151	150	150.5	151	150.7	1
1pm	152	153	150	151	151.5	151.5	3
2pm	150	150	150	149.5	149	149.7	1
3pm	151	150	150	150	150.5	150.3	1
						Grand Mean	**R-Bar**
						150.2333333	1.833333

The data presented is continuous data, and therefore, to measure the control limits, we must produce the X-Bar chart and the R-Bar chart to determine the control of the process.

X-Bar Chart

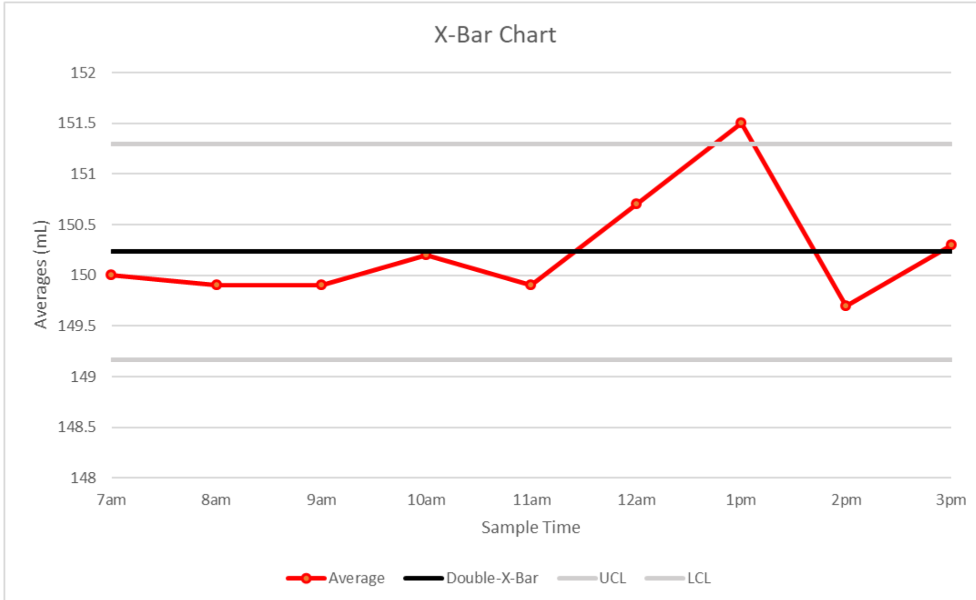
N = 5, $\bar{R}$ = 1.83, $\bar{\bar{x}}$ = 150.23 A_2 = 0.58 (taken from chart)

$$UCL = \bar{\bar{x}} + A_2\bar{R}$$
$$UCL = 150.23 + (1.83)(0.58)$$
$$UCL = 151.29$$

$$LCL = \bar{\bar{x}} - A_2\bar{R}$$
$$LCL = 150.23 - (1.83)(0.58)$$
$$LCL = 149.17$$

X-Bar	
Grand Mean	150.23
N	5
A_2	0.58
UCL	151.29
LCL	149.17

Time	Mean
7am	150
8am	149.9
9am	149.9
10am	150.2
11am	149.9
12am	150.7
1pm	151.5
2pm	149.7
3pm	150.3



<u>R-Bar Chart</u>

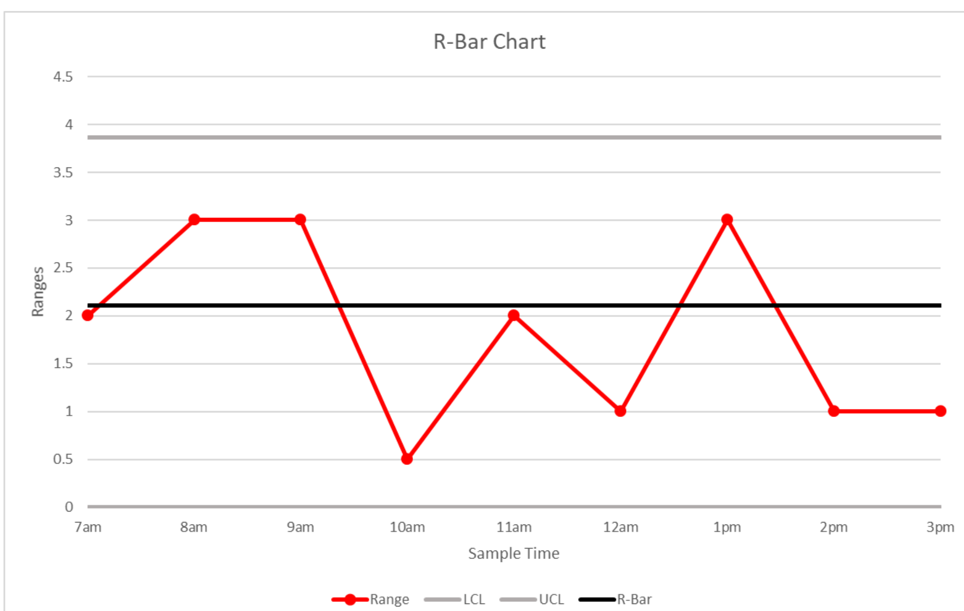
$\bar{R}$ = 1.83, Lower Range Factor D3 = 0, Upper Range Factor D4 = 2.11 (taken from chart)

$$UCL = D_4\bar{R}$$
$$UCL = (2.11)(1.83)$$
$$UCL = \ 3.868$$

$$LCL = D_3\bar{R}$$
$$LCL = (0)(1.83)$$
$$LCL = 0$$

R-Bar	
R-Bar	1.83
UCL	3.868
LCL	0

Time	Range
7am	2
8am	3
9am	3
10am	0.5
11am	2
12am	1
1pm	3
2pm	1
3pm	1



b) Is the process in control? Explain.

When it comes to analyzing the X-Bar chart, there is one point, 1 pm, which falls outside the control limits. There is need for investigation between 11 am and 1 pm, as there seems to be an upward trend, leading up to an average that falls outside the control limits. This would suggest that the process is out of control and that further investigation needs to be done to determine why and how to fix this issue.

When it comes to analyzing the R-Bar chart, the chart seems to show normal behaviour. A case could be made for erratic behaviour, where range spikes close to the LCL at 10am, but that is only one instance, and therefore it is assumed that the R-Bar chart shows normal behaviour.

Question 2

Hachette Book Group (HBG) is a division of the second-largest trade and educational book publisher in the world. To ensure the quality of the printed page, HBG uses SPC methods. In each production run, 1000 pages are randomly inspected. The examiners look for print clarity and whatever material is centered on the page properly. The number of defective pages in the last 45 production runs are listed below.

11	9	17	19	15	15	18	21	18
6	27	14	7	18	18	18	19	17
15	7	16	17	22	12	12	12	16
12	9	21	17	20	17	17	18	23
31	24	27	23	21	20	12	18	15

Required:

a) Construct the appropriate chart/s to determine the proportion of defective books. Provide numerical values and chart/s. (Keep 4 decimals in your calculations)

Because a page can be defective or not defective, we can conclude that this data is binary, and will therefore conclude that the P-chart must be created.

Production Run of 1000	Number of Defective Copies	Probability of a Defective Paper
1	11	0.011
2	9	0.009
3	17	0.017
4	19	0.019
5	15	0.015
6	15	0.015
7	18	0.018
8	21	0.021
9	18	0.018
10	6	0.006

11	27	0.027
12	14	0.014
13	7	0.007
14	18	0.018
15	18	0.018
16	18	0.018
17	19	0.019
18	17	0.017
19	15	0.015
20	7	0.007
21	16	0.016
22	17	0.017
23	22	0.022
24	12	0.012
25	12	0.012
26	12	0.012
27	16	0.016
28	12	0.012
29	9	0.009
30	21	0.021
31	17	0.017
32	20	0.02
33	17	0.017
34	17	0.017
35	18	0.018
36	23	0.023
37	31	0.031
38	24	0.024
39	27	0.027
40	23	0.023
41	21	0.021
42	20	0.02
43	12	0.012
44	18	0.018
45	15	0.015
		Mean of Probabilities
		0.0169

$$n = 1000, N = 45, z = 3; \textit{taken from the question}$$

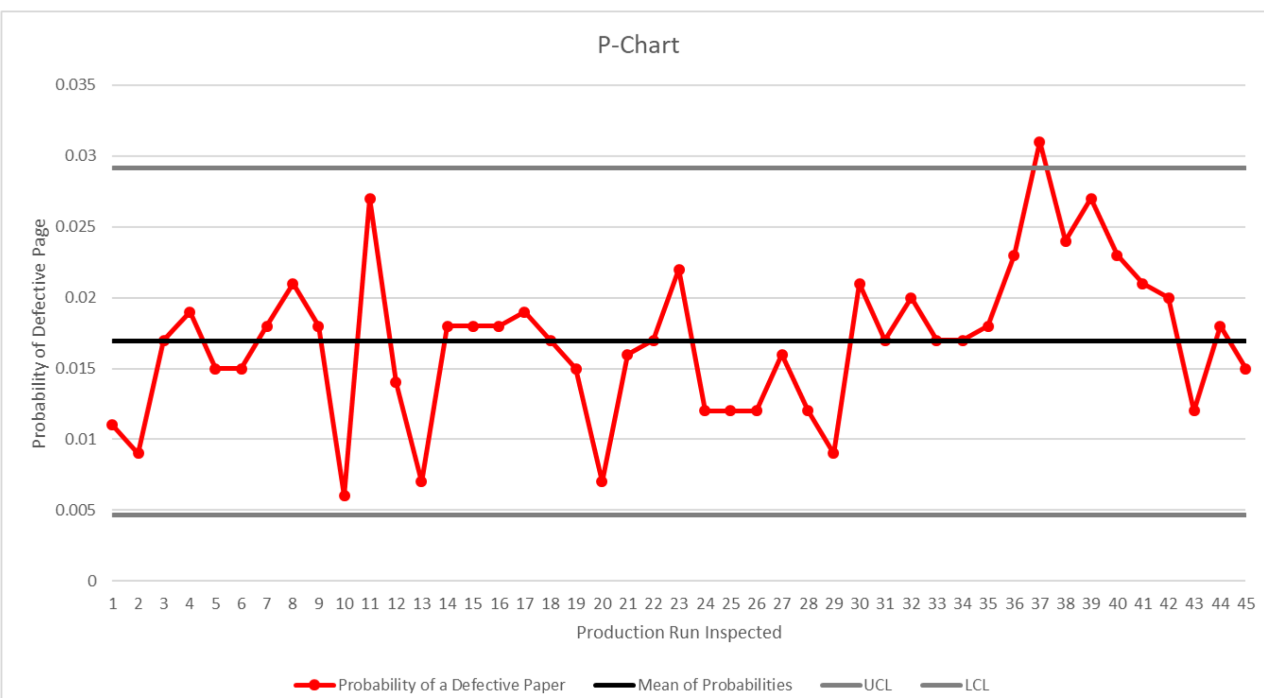
$$\bar{P} = \frac{1}{N}\sum_{i=1}^{N} p_i$$
$$\bar{P} = 0.0169$$

$$\sigma_p = \sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$$
$$\sigma_p = \sqrt{\frac{0.0169(1-0.0169)}{1000}}$$
$$\sigma_p = 0.0041$$

$$UCL = \bar{p} + z\sigma_p$$
$$UCL = 0.0169 + (3)(0.0041)$$
$$UCL = 0.0291$$

$$LCL = \bar{p} - z\sigma_p$$
$$LCL = 0.0169 - (3)(0.0041)$$
$$LCL = 0.0047$$

P-Bar	
Mean of Probabilities	0.0169
UCL	0.0291
LCL	0.0047



b) Can we conclude that the production process is under control? Explain.

There are instances where the graph shows that the process seems to fall out of control and that further investigation is needed to mitigate the issues.

The first of the issues that arises is that the graph seems to indicate instances where the process makes trends; increases/decreases continuously over consecutive production runs. This can be seen in production runs 17 through 20, 20 through 23, 34 through 37, and 39 through 43. The continuous increases and decreases suggest that the process tends to steadily increase or decrease over multiple production runs. This is a sign of a process being out of control, and further investigation is needed to determine the root cause and the solution to fixing the issue.

The second of the issues that a case could be made for is erratic behaviour. The graph depicts a process that seems to be out of control as there are instances where the probability for defective pages shoots up and then falls; movement between production runs 9 and 14. This suggests that the process is out of control, and further investigation is needed to determine the cause and solution to fixing the issue.

The final issue that arises from the P-Chart is of production run 37; it exceeds the upper control limit of the chart. This is following a positively moving trend which begins at production run 34. Because production run exceeds the upper control limit, there is sufficient information to suggest that the process is out of control, and further investigation is needed to determine the cause and solution to fixing the issue.

Question 3

Thirty samples of size 3 were taken from a machining process over a 15-hour period. Control charts (*x-Bar & R-Chart)* were built by the Director of Quality:

X-bar and R-Chart

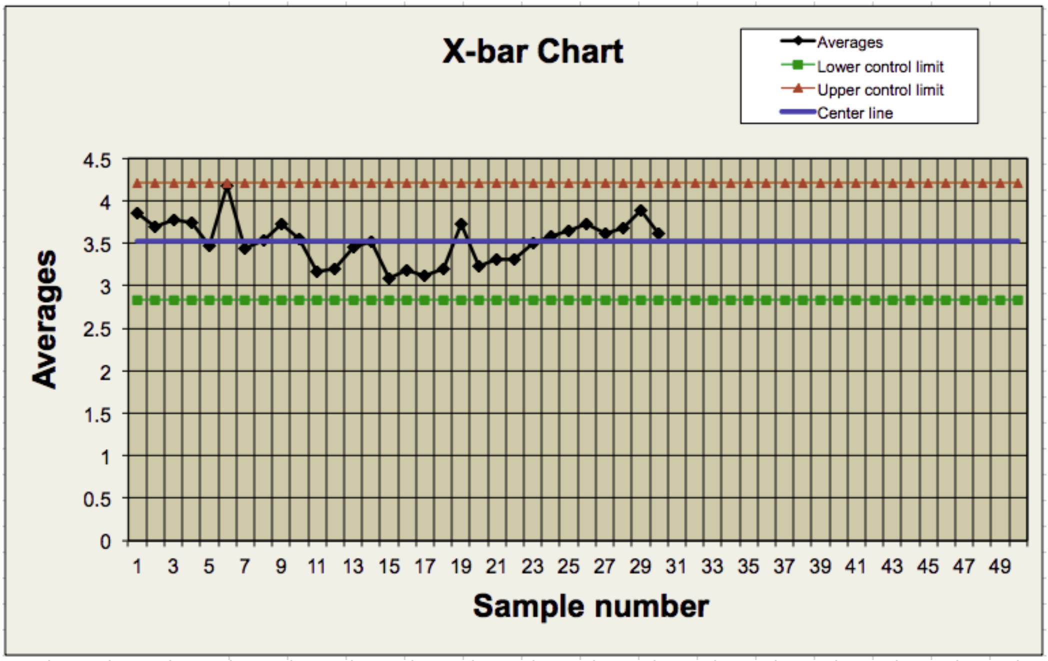
This spreadsheet is designed for up to 50 samples, each of a constant sample size from 2 to 10. Enter data only in yellow cells

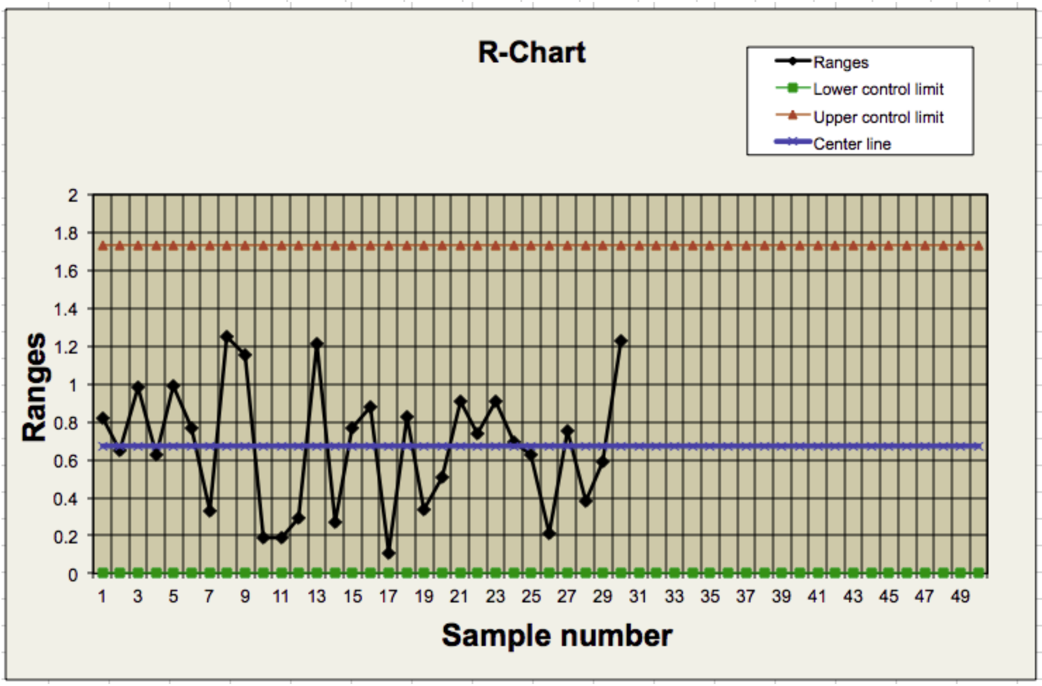
Charts are displayed below the calculations. Some resizing or rescaling of the charts may be required.

Number of samples (<= 50)	30
Sample size (2 - 10)	3

Grand Average	**3.53**		**A2**	**D3**	**D4**	**d2**
Average Range	**0.67**		**1.02**	**0**	**2.57**	**1.69**

Average	3.5260
Standard deviation	0.4166





a) Calculate Cp and Cpk , assuming that the specifications are 3.75 ± 0.30.

$$USL = 3.75 + 0.30 = 4.05$$

$$LSL = 3.75 - 0.30 = 3.45$$

$$\sigma = 0.4166 \textit{ ; given in the charts above}$$

$$C_p = \frac{USL - LSL}{6\sigma}$$

$$C_p = \frac{4.05 - 3.45}{(6)(0.4166)}$$

$$C_p = \frac{0.6}{2.4996}$$

$$C_p = 0.2400$$

$$C_{pk} = minimum\ of\ \left(\frac{USL - \bar{x}}{3\sigma}\right), \left(\frac{\bar{x} - LSL}{3\sigma}\right)$$

$$C_{pk} = minimum\ of\ \left(\frac{4.05 - 3.526}{(3)(0.4166)}\right), \left(\frac{3.526 - 3.45}{(3)(0.4166)}\right)$$

$$C_{pk} = minimum\ of\ \left(\frac{0.524}{1.2498}\right), \left(\frac{0.076}{1.2498}\right)$$

$$C_{pk} = minimum\ of\ (0.4193), (0.0608)$$

$$C_{pk} = 0.0608$$

b) Interpret the results for the manager of this process. Include comments on the above graphs as well as Cp and Cpk. What do you conclude about the process?

Cp

The Cp determines process capability. For a process to be capable, the Cp must be at least 1. A Cp of 1 means that the process can satisfy design specification limits 99.74% of the time, which suggests that the process is capable of meeting design requirements. The Cp of the process is 0.24, which is less than 1. This suggests that the process is not capable of meeting design requirements. This suggests that the machine is unable of meeting the design specifications, which is 3.75 ± 0.30.

Cpk

The Cpk determines the process capability index, which determines the desired dimensions of the good produced versus the actual dimensions of the good produced. For the process to meet specifications, the Cpk must be greater than or equal to 1. In this case, the Cpk is 0.0608, which falls well below the required limit of 1. This suggests that the process does not meet the desired design specifications.

Summary

The machine does not do a good job of meeting required design specifications. When it comes to Cp, the machine falls short of the desired Cp of 1, which suggests that the machine does not consistently produce goods that meet the requirements. The Cpk suggests that the machine does not do a good job of containing all the produced goods within the required design specifications. In summary, the machine does not do a good job at meeting design specifications, and must therefore be repaired or replaced by a better machine that will be able to get the job done correctly.