Practical – 2

Statistical Quality Control-II (Control Chart on Attribute)

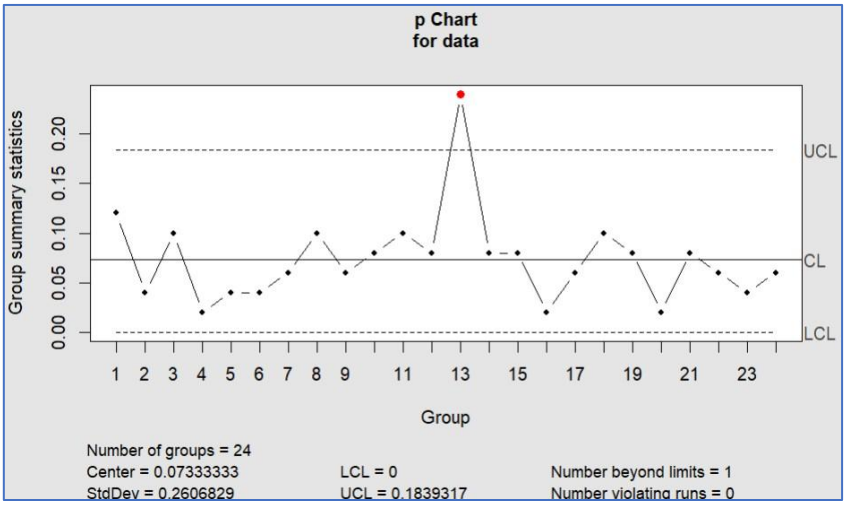
Q.1)

Each day a sample of 50 items from a production process was examined. The number of defectives found in each sample was as follows:

6	2	5	1	2	2	3	5	3	4	5	4	12	4	4	1	3	5	4	1	4	3	2	3

Draw a suitable control chart and check for control. What control limits would you suggest for future use?

```
> library(qcc)
> data<-c(6,2,5,1,2,2,3,5,3,4,5,4,12,4,4,1,3,5,4,1,4,3,2,3)
> sample_sizes<-rep(50,length(data))
> data1<-cbind(data,sample_sizes)
> #create p chart
> p_chart<-qcc(data,sizes=sample_sizes,type="p")
```



The process is mostly in control except for group 13, which needs investigation to identify potential issues. The next step is to remove this point and create the p chart again to check for stability.

```
> summary(p_chart)
```

Call:

qcc(data = data, type = "p", sizes = sample_sizes)

p chart for data

Summary of group statistics:

Min. 1st Qu. Median Mean 3rd Qu. Max.

0.02000000 0.04000000 0.07000000 0.07333333 0.08500000 0.24000000

Group sample size: 50

Number of groups: 24

Center of group statistics: 0.07333333

Standard deviation: 0.2606829

Control limits:

LCL UCL

0 0.1839317

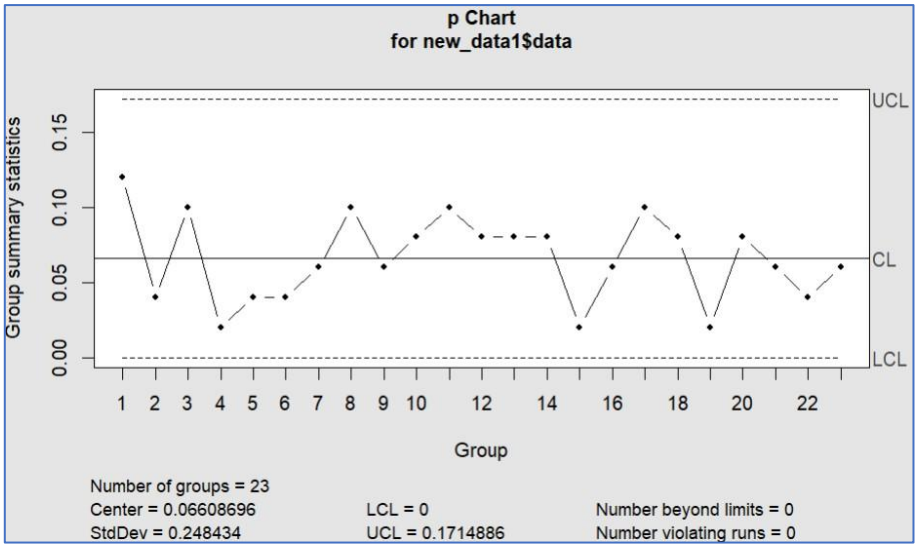
0 0.1839317

0 0.1839317

> #new p chart

> new_data1<-data.frame(data1[-13,])

> p_chart<-qcc(new_data1$data,sizes=new_data1$sample_sizes,type="p")



The process appears to be stable and in control, with no unusual variations in the defect proportion across the groups.

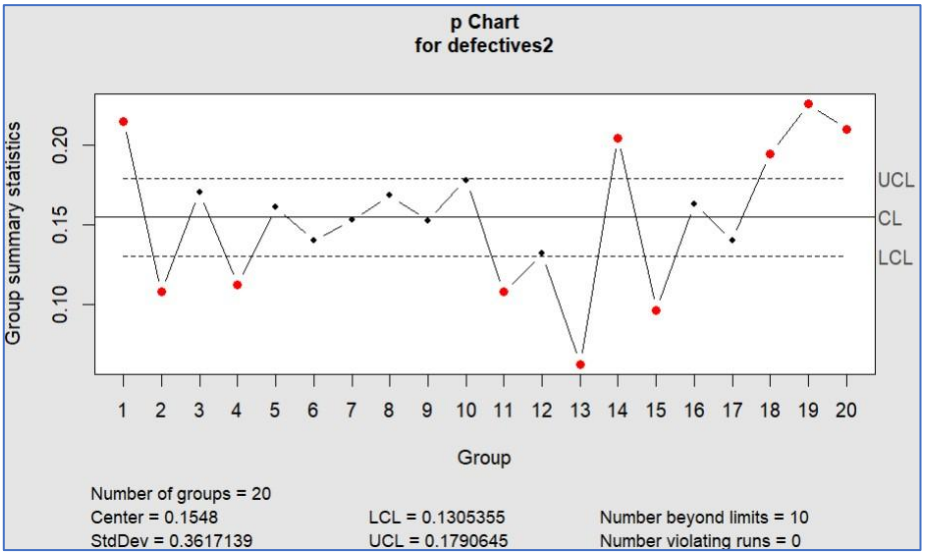
Q.2)

The following are the figures of defectives in 20 lots each containing 2000 rubber belts:

430	216	341	225	322	280	306	337	305	356
216	264	126	409	193	326	280	389	451	420

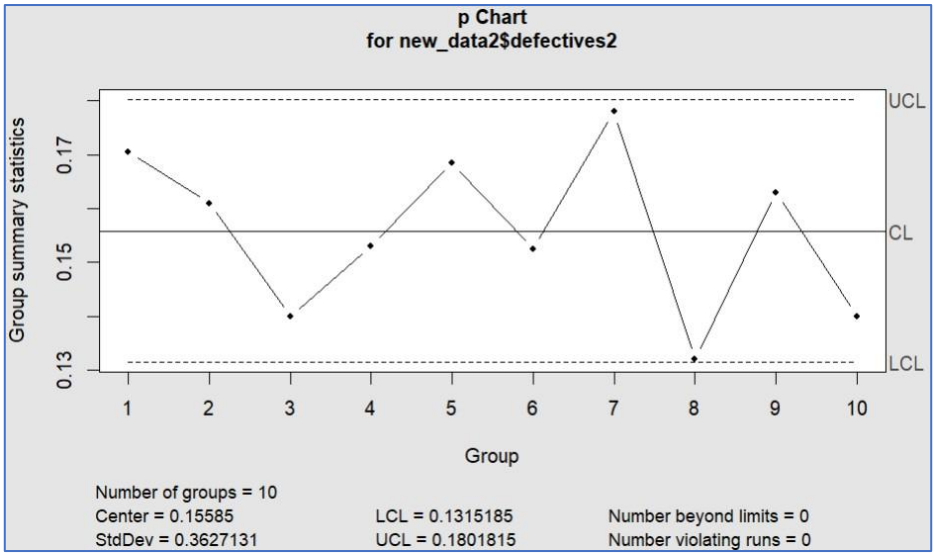
Draw a control chart for fraction defective and comment on whether the process is in control or not.

```
> defectives2<-
c(430,216,341,225,322,280,306,337,305,356,216,264,126,409,193,326,280,389,451,420)

> sample_sizes1<-rep(2000,length(defectives2))

> data2<-cbind(defectives2,sample_sizes1)

> p_chart<-qcc(defectives2,sizes=sample_sizes1,type="p")
```



The p chart shows ten points (Groups 1,2,4,11,13,14,15,18,19,20) beyond the control limits, indicating potential issues. The next step is to remove these points and create the p chart again to check for stability.

```
> new_data2<-data.frame(data2[-c(1,2,4,11,13,14,15,18,19,20),])

> p_chart<-qcc(new_data2$defectives2,sizes=new_data2$sample_sizes,type="p")
```



The process appears to be stable and in control, with no unusual variations in the defect proportion across the groups.

Q.3)

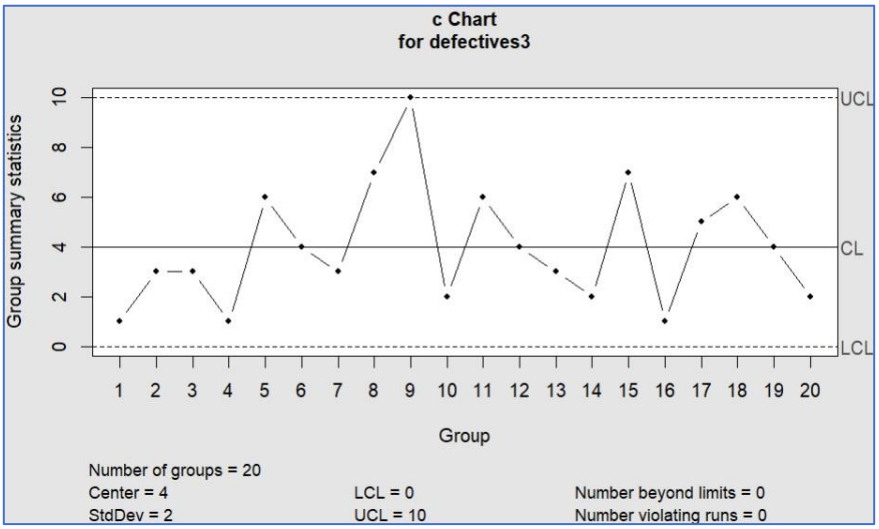
The number of defects in 20 pieces of cloths, each of 100 meters lengths is given below:

1	3	3	1	6	4	3	7	10	2	6	4	3	2	7	1	5	6	4	2

Draw the appropriate chart and say whether the process can be considered to be in control.

```
> defectives3<-c(1,3,3,1,6,4,3,7,10,2,6,4,3,2,7,1,5,6,4,2)
```

```
> c_chart<-qcc(defectives3,type="c")
```



The process appears to be stable and in control, with no unusual variations in the defect proportion across the groups.

```
> summary(c_chart)
```

Call:

qcc(data = defectives3, type = "c")

c chart for defectives3

Summary of group statistics:

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
1.0	2.0	3.5	4.0	6.0	10.0

Group sample size: 1

Number of groups: 20

Center of group statistics: 4

Standard deviation: 2

Control limits:

LCL	UCL
0	10

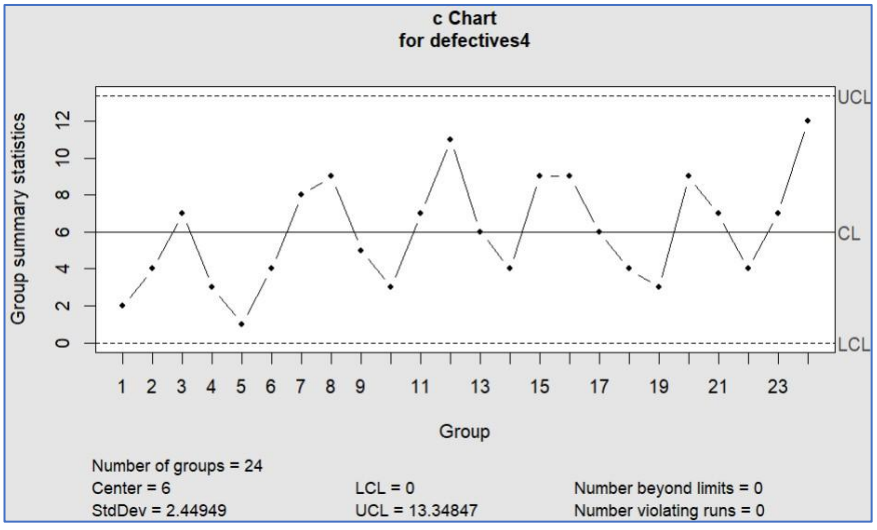
Q.4)

The following number were found on articles being produced, when inspected 8 times a day on 3 days:

2	4	7	3	1	4	8	9	5	3	7	11	6	4	9	9	6	4	3	9	7	4	7	12

Draw a control chart and comment on your findings. Suggest the value of 'number of defects' to be used in future.

```
> defectives4<-c(2,4,7,3,1,4,8,9,5,3,7,11,6,4,9,9,6,4,3,9,7,4,7,12)
> c_chart<-qcc(defectives4,type="c")
```



The process appears to be stable and in control, with no unusual variations in the defect proportion across the groups.

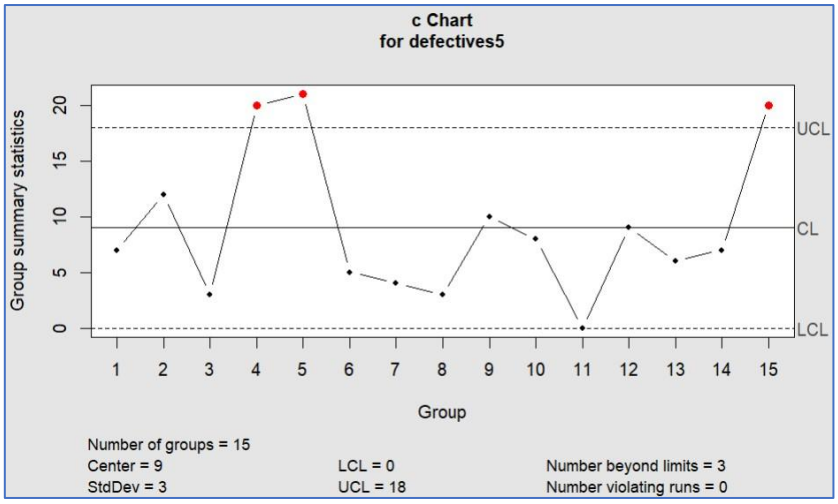
```
> summary(c_chart)

Call:

qcc(data = defectives4, type = "c")

c chart for defectives4

Summary of group statistics:

   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.

   1.00    4.00    6.00    6.00    8.25   12.00

Group sample size:  1

Number of groups:  24

Center of group statistics:  6

Standard deviation:  2.44949

Control limits:

 LCL      UCL

   0 13.34847
```

Q.5)

Draw a suitable control chart for following data pertaining to the number of coloured threads (considered as defects) in 15 pieces of a cloth of certain make of synthetic fiber and state your conclusion:

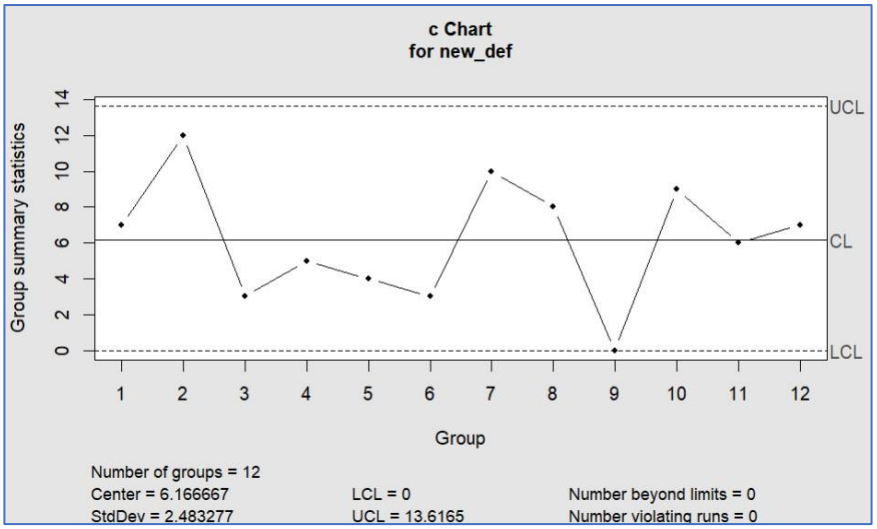
7	12	3	20	21	5	4	3	10	8	0	9	6	7	20

```
> defectives5<-c(7,12,3,20,21,5,4,3,10,8,0,9,6,7,20)

> c_chart<-qcc(defectives5,type="c")
```



The p chart shows ten points (Groups 4 & 5) beyond the control limits, indicating potential issues. The next step is to remove these points and create the p chart again to check for stability.

```
> summary(c_chart)

Call:

qcc(data = defectives5, type = "c")

c chart for defectives5

Summary of group statistics:

   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.

    0.0     4.5     7.0     9.0    11.0    21.0

Group sample size:  1

Number of groups:  15

Center of group statistics:  9

Standard deviation:  3

Control limits:

 LCL UCL

   0  18

> new_def<-defectives5[-c(4,5,15)]

> c_chart<-qcc(new_def,type="c")
```



The process appears to be stable and in control, with no unusual variations in the defect proportion across the groups.

Q.6) Using the orangejuice dataset in R, create a control chart for attributes to monitor the quality of juice samples. Analyze the chart for both the trial and further samples, identifying any points that are out of control. Provide an explanation for any out-of-control points observed in the context of the dataset.

```
> ?orangejuice
> data(orangejuice)
> orangejuice
   sample  D size trial
1       1 12   50  TRUE
2       2 15   50  TRUE
3       3  8   50  TRUE
4       4 10   50  TRUE
5       5  4   50  TRUE
6       6  7   50  TRUE
7       7 16   50  TRUE
8       8  9   50  TRUE
9       9 14   50  TRUE
10     10 10   50  TRUE
```

11	11	5	50	TRUE
12	12	6	50	TRUE
13	13	17	50	TRUE
14	14	12	50	TRUE
15	15	22	50	TRUE
16	16	8	50	TRUE
17	17	10	50	TRUE
18	18	5	50	TRUE
19	19	13	50	TRUE
20	20	11	50	TRUE
21	21	20	50	TRUE
22	22	18	50	TRUE
23	23	24	50	TRUE
24	24	15	50	TRUE
25	25	9	50	TRUE
26	26	12	50	TRUE
27	27	7	50	TRUE
28	28	13	50	TRUE
29	29	9	50	TRUE
30	30	6	50	TRUE
31	31	9	50	FALSE
32	32	6	50	FALSE
33	33	12	50	FALSE
34	34	5	50	FALSE
35	35	6	50	FALSE
36	36	4	50	FALSE
37	37	6	50	FALSE
38	38	3	50	FALSE
39	39	7	50	FALSE
40	40	6	50	FALSE
41	41	2	50	FALSE

42 42 4 50 FALSE

43 43 3 50 FALSE

44 44 6 50 FALSE

45 45 5 50 FALSE

46 46 4 50 FALSE

47 47 8 50 FALSE

48 48 5 50 FALSE

49 49 6 50 FALSE

50 50 7 50 FALSE

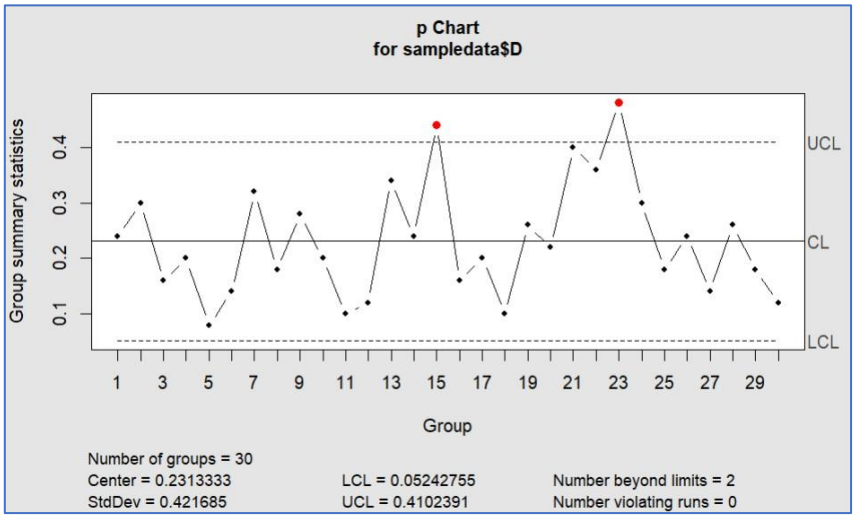
51 51 5 50 FALSE

52 52 6 50 FALSE

53 53 3 50 FALSE

54 54 5 50 FALSE

```
> attach(orangejuice)
> sampledata<-orangejuice[1:30,]
> qcc(sampledata$D,sizes=sampledata$size,type="p")
```



The p chart shows ten points (Groups 15 & 24) beyond the control limits, indicating potential issues. The next step is to remove these points and create the p chart again to check for stability.

List of 11

$ call : language qcc(data = sampledata$D, type = "p", sizes = sampledata$size)

$ type : chr "p"

$ data.name : chr "sampledata$D"

$ data : int [1:30, 1] 12 15 8 10 4 7 16 9 14 10 …

..- attr(*, "dimnames")=List of 2

$ statistics: Named num [1:30] 0.24 0.3 0.16 0.2 0.08 0.14 0.32 0.18 0.28 0.2 …

..- attr(*, "names")= chr [1:30] "1" "2" "3" "4" …

$ sizes : int [1:30] 50 50 50 50 50 50 50 50 50 50 …

$ center : num 0.231

$ std.dev : num 0.422

$ nsigmas : num 3

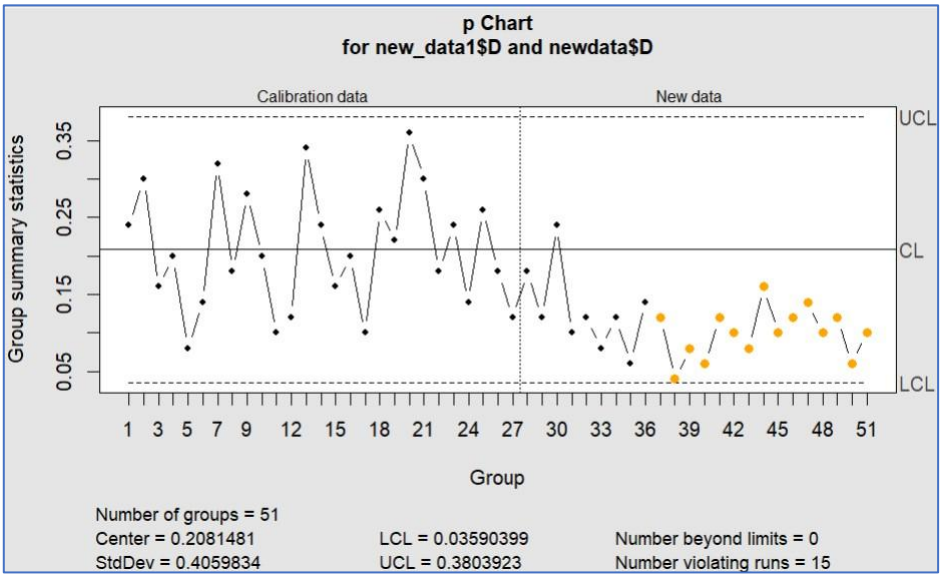
$ limits : num [1:30, 1:2] 0.0524 0.0524 0.0524 0.0524 0.0524 …

..- attr(*, "dimnames")=List of 2

$ violations:List of 2

- attr(*, "class")= chr "qcc"

```
> new_data1<-data.frame(sampledata[-c(15,23,21),])
> newdata<-orangejuice[31:54,]
> qcc(new_data1$D,new_data1$size,type="p",newdata=newdata$D,newsizes = newdata$size)
```



List of 15

$ call : language qcc(data = new_data1$D, type = "p", sizes = new_data1$size, newdata = newdata$D, newsizes = newdata$size)

$ type : chr "p"

$ data.name : chr "new_data1$D"

$ data : int [1:27, 1] 12 15 8 10 4 7 16 9 14 10 …

..- attr(*, "dimnames")=List of 2

$ statistics : Named num [1:27] 0.24 0.3 0.16 0.2 0.08 0.14 0.32 0.18 0.28 0.2 ...

..- attr(*, "names")= chr [1:27] "1" "2" "3" "4" ...

$ sizes : int [1:27] 50 50 50 50 50 50 50 50 50 50 ...

$ center : num 0.208

$ std.dev : num 0.406

$ newstats : Named num [1:24] 0.18 0.12 0.24 0.1 0.12 0.08 0.12 0.06 0.14 0.12 ...

..- attr(*, "names")= chr [1:24] "28" "29" "30" "31" ...

$ newdata : int [1:24, 1] 9 6 12 5 6 4 6 3 7 6 ...

$ newsizes : int [1:24] 50 50 50 50 50 50 50 50 50 50 ...

$ newdata.name: chr "newdata$D"

$ nsigmas : num 3

$ limits : num [1:51, 1:2] 0.0359 0.0359 0.0359 0.0359 0.0359 ...

..- attr(*, "dimnames")=List of 2

$ violations :List of 2

- attr(*, "class")= chr "qcc"

Q.7)

Samples of 100 tubes are drawn randomly from the output of a process that producesseveral thousand units daily. The result of 15 samples is shown below:

Sample No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Number of defective tubes	8	10	13	9	8	10	14	6	10	13	18	15	12	14	9

On the basis of the information given above, find the limits for

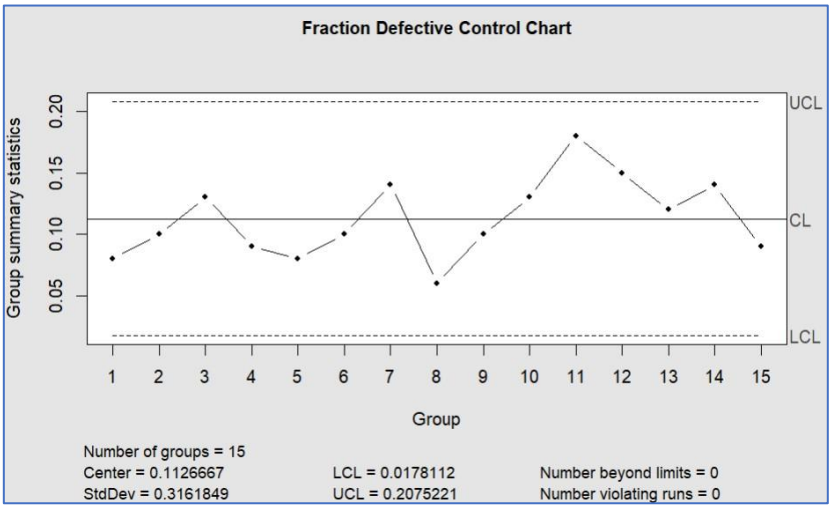
(a) Fraction defective chart

(b) Chart for number of defectives.

Also draw a control chart for (a). What conclusion can you draw from the chart?

```
> defective <- c(8, 10, 13, 9, 8, 10, 14, 6, 10, 13, 18, 15, 12, 14, 9)
> sample_size <- 100
> # Plot p-Chart and display summary
```

```
> library(qcc)
> p_chart <- qcc(data = defective, type = "p", sizes = rep(sample_size, length(defective)),
+                title = "Fraction Defective Control Chart")
```




```
> summary(p_chart)  # Prints control limits and key statistics
```

Call:

qcc(data = defective, type = "p", sizes = rep(sample_size, length(defective)), title = "Fraction Defective Control Chart")

p chart for defective

Summary of group statistics:

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
0.0600000	0.0900000	0.1000000	0.1126667	0.1350000	0.1800000

Group sample size: 100

Number of groups: 15

Center of group statistics: 0.1126667

Standard deviation: 0.3161849

Control limits:

LCL	UCL
0.0178112	0.2075221
0.0178112	0.2075221
…	
0.0178112	0.2075221