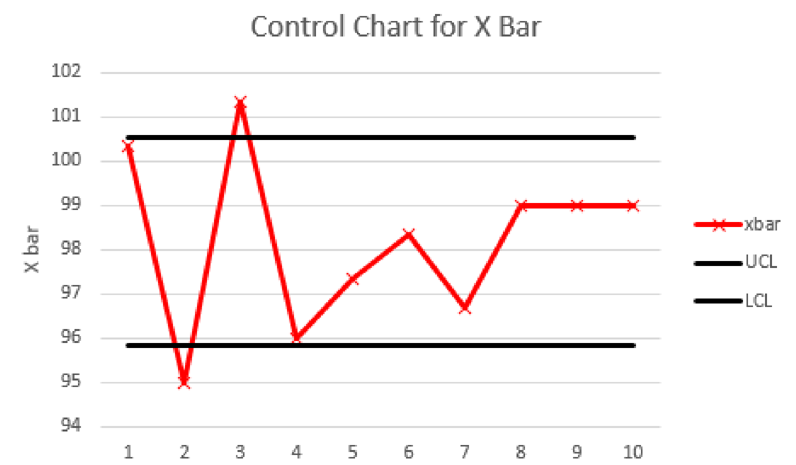
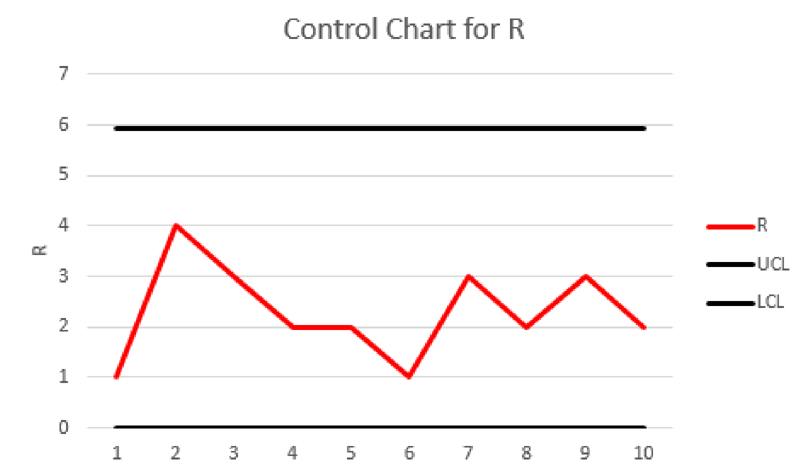
NOTE*** Computations were performed in Excel file attached to submission

1. We consider the data in problem one. First, we compute the $\bar{x}$ and R variables from the existing data. Then, we compute $\bar{\bar{X}} = 98.2$, and $\bar{R} = 2.3$. With these variables computed,we construct the following plots,





Here, we see that the $\bar{X}$ chart contains out of control points. This points to an ability to discriminate between different parts. Conversely, the R control chart is within control. This shows us that the operator making the measurements is being consistent, a good sign. So, we consider the measurement error. We know that this error is normally distributed with variance= σ^2_{gauge}. Here, $\sigma^2_{gauge} = 1.845618$.
Next, we compute $\sigma^2_{total} = 4.717241$. Thus, we may compute,

$$\sigma_{prod} = \sqrt{\sigma^2_{total} - \sigma^2_{gauge}} = 1.144961$$

Next, we compute the percent of variability of the gauge component, as,

$$\%Gauge = \frac{\sigma_{gauge}}{\sigma_{total}} = 0.625499$$

Finally, we compute the P/T ratio as,

$$P/T = \frac{6 * 1.358535}{115 - 85} = 0.271707$$

Because $P/T > 0.1$, we consider the gauge to be inadequate.

2. Using the data from problem 2, we compute the following, $\bar{X}_1 = 50.0333$, $\bar{X}_2 = 49.86667$, $R_1 = 1.7$, $R_2 = 2.3, \bar{R} = 2$.

From these basic descriptive statistics, we may now compute,

$$\begin{aligned}\sigma_{repeat} &= \frac{\bar{R}}{1.693}\\ &= 1.181335\\ \sigma_{reprod} &= \frac{RANGE(\bar{X})}{1.128}\\ &= 0.147754\end{aligned}$$

The standard deviation of measurement error is computed as,

$$\sigma_{MeasErr} = \sqrt{\sigma_{repeat}^2 + \sigma_{reproduce}^2} = 1.190539$$

Finally, we compute,

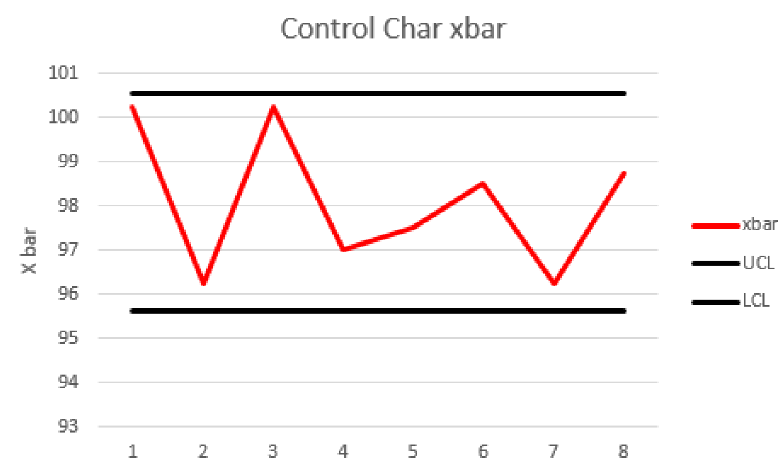
$$P/T = \frac{6 * \sigma_{gauge}}{60 - 40} = 0.3544$$

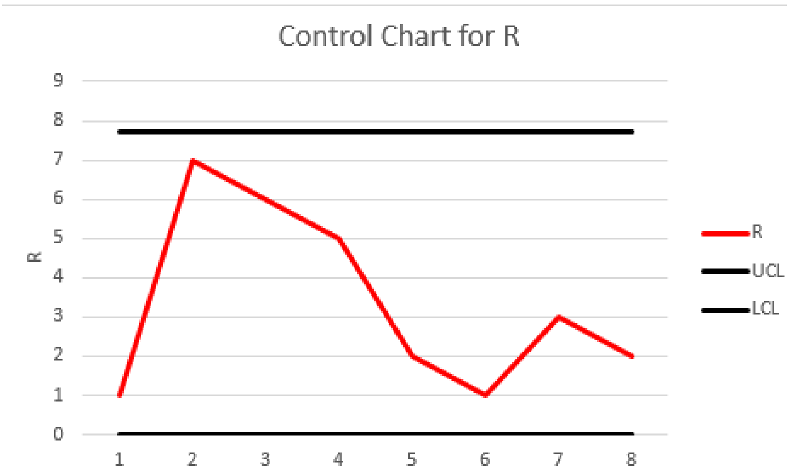
Since, $P/T > 0.1$, the gauge is inadequate.

3. We consider the data in problem 3. As before, we compute the following,

$$\bar{X} = 98.09375, \ \bar{R} = 3.375$$

From this $\bar{X}$ and R data, we construct the control charts as before,





From these plots, we see that the gauge has low discriminating power, but the operator has high consistency. Next, we compute the total variability and product variability,

$$\sigma_{tot}^2 = 4.732863, \quad \sigma_{prod}^2 2.046066$$

Next, we compute,

$$\%Gauge = \frac{\sigma_{gauge}}{\sigma_{total}} = 0.753452$$

Finally, we compute,

$$P/T = \frac{6 * \sigma_{gauge}}{115 - 85} = 0.327829$$

Since, $P/T > 0.1$, the gauge is inadequate.

4. We compute with the new data, as before,

$$\sigma_{repeat} = 1.279779, \quad \sigma_{reprod} = 0.689112$$

We expect that these variables are normally distributed with mean zero and variance from above. Next, we compute the standard deviation of measurement error as,

$$\sigma_{MeasErr} = \sqrt{\sigma_{repeat}^2 + \sigma_{reproduce}^2} = 1.453517$$

Finally, we compute,

$$P/T = \frac{6 * \sigma_{gauge}}{60 - 40} = 0.383934$$

Since, $P/T > 0.1$, the gauge is inadequate.