**Problem One:**

* 2. After plotting shear stress vs time, we can see that the shear stress starts from zero and after a certain time it starts increasing, increases to a certain value and then decreases again to a certain lower value. The increasing period happens when the sample does not move due to static friction. So, shear stress increases until it overcomes the static friction value and the sample starts slipping. When it starts slipping, the friction in action is now kinetic friction. So, the shear stress starts decreasing until the friction increases to static value again and the shear stress starts building up again. This process continues till the end of the experiment and finally the shear stress decreases to zero. There are some points when we see very clear decrease or difference in the stick slip event. These are the times when the apparatus was vibrated externally and the vibration affected the shear stress increment also.
* 3. The time of stick slip events has been identified. Our policy was to define a threshold value for the time derivative of stress and to identify the time values when the respective time derivative value was lower than the threshold value. We used vectorizing method for this. Took the difference of each shear stress value and the previous value. Also did same for the time vector. Then calculated the derivative of shear stress in respect of time. After identifying the time values calculated the average time using: *(last time value – first time value)/ (length of time - 1).* The average time between events was found as, Average time = 3.8376 seconds.
* 4. We used the polyfit function without using a loop. We used polyfit to get the co-effecients of polynomial and then evaluated that polynomial using polyval for each value of time vector. Then subtracted that evaluated vector from the original layer thickness data to remove the effect of material loss.

The matlab built in function ‘detrend’ was used and it gave us the same result. We plotted both and found them exactly matching. Since, it was difficult to distinguish one from another, we displayed two random values from both vectors having same index and also found them matched with only minor difference after decimal point.

* 5. To identify the time when the vibration was applied we plotted vibration vs time and found that there were some points where the vibration amplitude was clearly higher. Our method was to set a minimum amplitude value for the vibration and to identify the time values related to those high amplitudes. Then to choose any one (we chose the last one) time from these time values and determine a lower limit and an upper limit to plot shear stress in respect of that time range. The program will set the lower and upper limit automatically and will give a plot within that range. If we look at the plot we can very clearly see that there is a sudden decrease in the increment of shear stress value and it did not reach to the level of previous points. And when decreased, decreased to a level little bit more than the previous points. This happened because the apparatus was externally vibrated at that time that affected the stick slip event also. (Plot is as png. there)

**Problem Two:**

*What is different about this experiment?*

* 7. If we plot the shear stress vs time from the second data, we see that the plot does not come like the first problem. Yes, there are stick slip events but it comes like some small packages or stairs. In each stair step, there is a package that contains some stick slip events. To investigate the reason behind this, we loaded both the data into matlab and plotted all the components vs time into two subplots and tried to identify which components behaved differently. We found that there was no normal stress applied in the first experiment while there was normal stress applied in the second experiment.

If we look at the figure (Shear stress and Normal stress vs Time), included in the public folder under second question) and zoom in the, we can clearly see that the value of normal stress (the stars) for the second problem is not zero always. That means, in this experiment along with shear stress normal stress was also applied and our shear stress vs time curve changed and jumped to upper step or lower step (after the top step) because of this normal stress application. But within a single step, the behavior of shear stress vs time curve is similar to the first problem (stick slip behavior). We also found that for the *second experiment*, load point displacement and elastically correlated displacement components increased with time in a significant manner (figure included).

*Does the friction coefficient change with normal stress? Plot*

* 8. If we plot the normal stress vs time and also plot the friction co efficient vs time and compare them we see that for each sharp decrease in the value of Normal stress is related to the decrease in friction co efficient value. When the value of normal stress decreased significantly, the friction co efficient also decreased and again increased with the increment of the value of normal stress. Even the magnitude of reduction seems co-related. Figure included.

*Does the time between events change with applied normal stress? Scatter Plot.*

* 9. Yes, the average time between events for the second experiment (Avg. time = 1.6814 seconds) was found less than the first experiment. For the first experiment, it was more than 3 seconds. This is obviously for the application of normal stress that reduced the average waiting time between events.

**Note: I am sorry. I did not quite understand this question that what you wanted here from me? I am answering according to my best understanding of this question.**

A scatter plot is included that shows that there is a relation between normal stress application and decrease in derivative value. (The figure should be zoomed in).