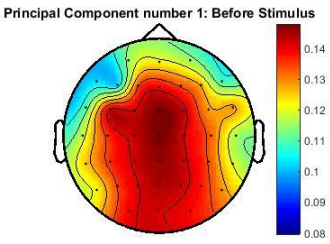
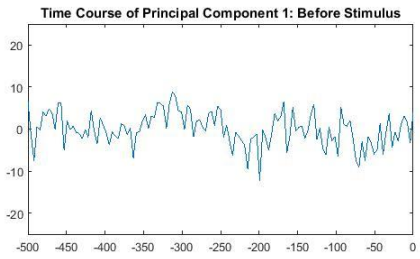
Brain Computer Interfaces (Fall 2017, ELE 594)

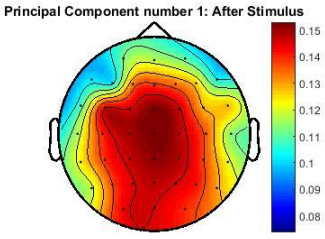
2nd Homework Solution

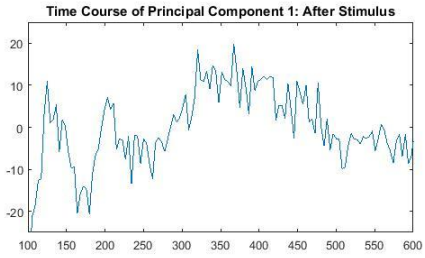
Question 1:

PCA on broadband data was performed using 2 time windows one before and one after trial onset. The epochs were separated and centered by subtracting the mean of each epoch. The covariance matrix was calculated for each trial after centering, then an average covariance matrix was computed over all the trials. Eigen value decomposition was performed using the MATLAB function eig such that: Eig (cov) = VLV^{-1}. Each column of V represents an eigen vector, and L is a diagonal matrix containing the corresponding eigen values. By sorting the eigen vectors in descending order, the principle components (i.e., eigen vectors) ordered from the ones expressing the maximum variance to the least. Topographical maps of the first 4 components defined pre and post-trial were plotted, and the time courses defined by them on all the trials averaged.

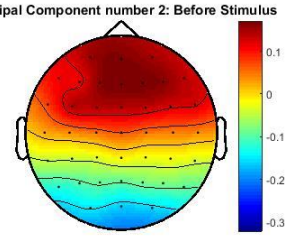




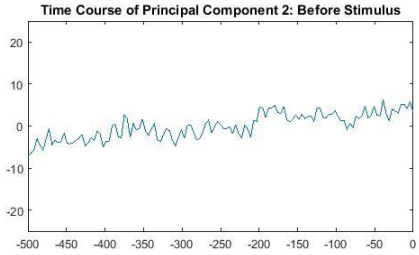




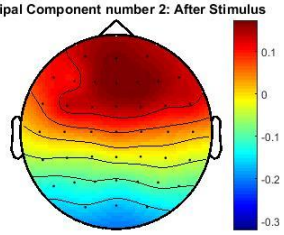
Principal Component number 2: Before Stimulus



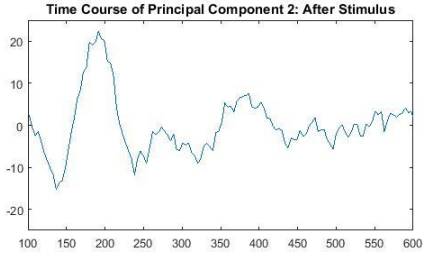
Time Course of Principal Component 2: Before Stimulus



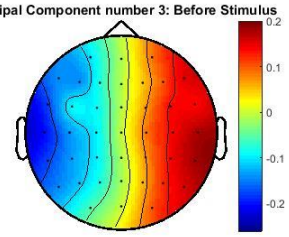
Principal Component number 2: After Stimulus



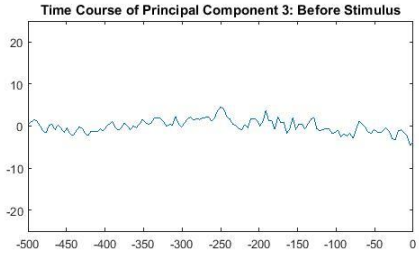
Time Course of Principal Component 2: After Stimulus



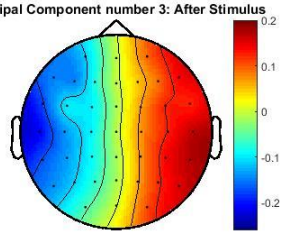
Principal Component number 3: Before Stimulus



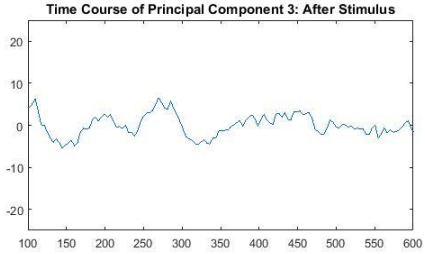
Time Course of Principal Component 3: Before Stimulus

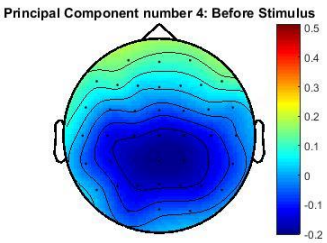


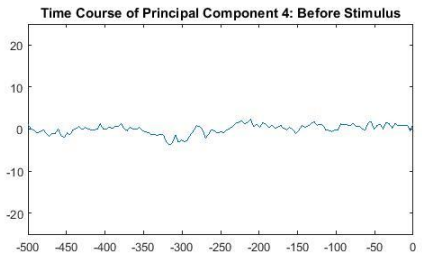
Principal Component number 3: After Stimulus

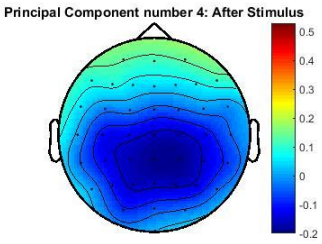


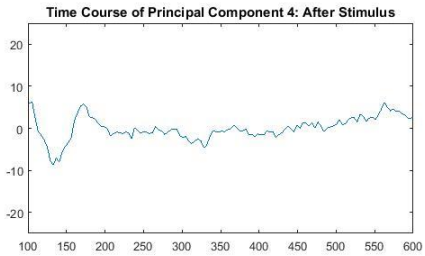
Time Course of Principal Component 3: After Stimulus











The projection of the post-stimulus epoch on the first and second PCs show a positive deflection around 400 ms, indicative of a cognitive task, and a deflection around 150 ms, indicative of a sensory task (which appeared earlier) respectively. The projection of the post-stimulus epoch on the third and fourth PCs demonstrate other ERP components associated with the task. As it is observed, no considerable pattern is seen in the projected pre-stimulus epoch indicative of no-task relevant activity.