**Final-EENG 860**

**Due date: Dec 17, 2019 @ 5:30pm**

The use of gas sensors together with pattern classification methods plays a significant role in recognition and classification of chemical compounds and detection of their harmful effects. Designing these less costly systems is important also for the industry.

Alcohols constitute a huge portion of these compounds, and are used largely in hygiene products and cosmetics. The aim of this study is to classify 5 different types of alcohols – 1) 1-octanol, 2) 1-propanol, 3) 2-butanol, 4) 2-propanol and 5) 1-isobutanol using QCM (quartz crystal microbalance) sensors of different structures. Among these alcohols

1) 1-octanol is known as fatty alcohol. Its chemical formula is CH3(CH2)7OH, and with its strong odor it is generally used in perfumes and flavorings.

2) 1-propanol is an aliphatic alcohol with a chemical formula of CH3CH2CH2OH. While it very much resembles ethyl alcohol chemically, it has a strong and toxic odor. It is rather used as a solvent.

3) 2-butanol is called as secondary alcohol, and has a formula of CH3CH(OH)CH2CH3. Again this alcohol is a strong solvent.

4) 2-propanol is an isopropyl alcohol with a formula of CH3CHOHCH3. It is a compound used at home and in industry, and an example of secondary alcohol.

5) 1- isobutanol has a formula of (CH3)2CHCH2OH. It is known to be used as a solvent.

QCM sensor is a physical device that is sensitive to resonance frequency Δf changes. QCM sensors with different structures may react very differently. The reason of using QCM sensors in this study is the successful reaction of these sensors to the compounds. Despite their success levels, the costs of the QCM sensors are low. The aim of the study is to measure the reaction of different QCM sensors to this 5 different alcohols, and to determine which type of sensor is more successful in classification of these alcohols.

Use the attached dataset for 5 QCM sensors. The first 10 numbers are the resonance frequency Δf changes for different proportion of air in each gas concentration. The last 5 numbers determine the class of gas. For example, if the gas be octanol, the first number is 1 and the last 4 numbers are zero.

Compare the classification performance for classifying these 5 different types of alcohols using supervised classifiers SVM and HMM and Unsupervised classifiers KNN and FCM clustering approaches when 80% of data in each class are selected for training and the remaining 20% for testing.

Apply these classifiers to the dataset for each QCM sensor separately and compare the performance of sensors for classification. For each dataset and classifier calculate the confusion matrix, TP, FP, TN, FN rates, and total accuracy for 5 classes.

Submit all your results in power point presentation along with all codes. Name the codes with classification method\_QCMXX\_Last name\_first name where XX is the sensor number.

Bonus:

Combine the data of all sensors, so the total number of features for each gas concentration would be 10\*5=50. Apply Minimum Redundancy Maximum Relevance approach to find the best features among these 50 features that gives you the best classification performance and calculate the confusion matrix, TP, FP, TN, FN rates, and total accuracy for 5 classes. Compare the performance of the classifiers.