**MAE 510 WIND ENERGY COVERSION:**

During my academic journey at UB, I cultivated a profound interest in wind energy. The course led by Dr. John Hall was a significant factor in my decision to attend UB. Wind energy, with its myriad benefits, has become a favored option for renewable energy. It is an environmentally friendly and limitless energy solution that produces electricity without any direct emissions or air pollutants, thus reducing climate change and enhancing air quality. Wind resources are plentiful, stable, and available in various regions. Wind energy projects contribute to employment opportunities in areas such as manufacturing, construction, operation, and maintenance, thereby stimulating local economies. I am confident that offshore wind will play a vital role in our transition away from fossil fuels.

The initial coursework provided a comprehensive understanding of wind energy generation from a mechanical perspective, along with various techniques for harnessing energy from wind. Our initial classes were dedicated to reviewing a patent dispute between Siemens and GE. We also allocated time to discuss and present our research on topics like Digital Twins, Smart Microgrids, and several innovations in wind turbine blade design. These discussions served as a catalyst for our final projects.

Unexpectedly, midway through the semester, Dr. Hall was unable to continue teaching due to unforeseen circumstances. As a result, the class was handed over to Dr. Teng Wu from the Civil and Structural Engineering department. He played a crucial role in guiding us to select our topics and helped us excel in our project.

For our capstone project titled “Prediction of Wind Turbine Maintenance Using Efficiencies of Turbine Power,” my team and I focused on developing an efficiency equation for wind turbines using a machine learning algorithm. We used MATLAB to analyze SCADA data from a wind turbine in Turkey, which was imported and processed through the machine learning algorithm **(Figure 1).** The software enabled the analysis and visualization of efficiency data over time. Our goal was to predict turbine efficiency over time to schedule repairs based on critical efficiency thresholds. We employed a long short-term memory algorithm to examine the efficiency decline of the wind turbine over a year **(Figure 2).** We cleaned the dataset by eliminating points with zero wind speed and values beyond the turbine’s operational range **(Figure 3).** The remaining data was used to compute efficiency and train the machine learning model. The machine learning algorithm accurately predicted the efficiency decline of the wind turbine over time **(Figure 4).** By analyzing the data, we were able to chart the overall deterioration of the turbine’s efficiency. The study demonstrated the feasibility of using machine learning to enhance wind turbine lifespan and reduce the levelized cost of energy.

This course served as the foundation for me to undertake an individual problem with Dr. Wu, and I continued to apply the knowledge and skills acquired from the course in my research. I am deeply grateful for the insights gained and the expansion of my knowledge base in wind turbine designs. I enthusiastically endorse this enriching course to anyone aspiring to specialize in renewable energy.

A graph of data with blue lines

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**Figure 1.** Machine learning algorithm results

Chart

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**Figure 2.** Smaller data set results

Chart, box and whisker chart

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**Figure 3.** Filtered Predicted Efficiency Plot

Chart, bar chart

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**Figure 4.** Machine Learning Training Progress