Project Description for FYP-UCC-Physics- Sept 2019:

Analytical Modelling and Simulation for Energy Harvesting from Magnetoelectric stack

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The purpose of this project is to design multiple unique topologies of magnetoelectric stack that would increase the Magnetoelectric Voltage Coefficient (MEVC) from that of a basic planar stack to a value close to that of the current state of the art devices. The topologies would then be used to alter a pre-existing analytical model, this would be done to validate the accuracy of the model and to delineate the design efficacy. The goal of working with few unique designs would be to create a design platform that would lead to an increased Magnetoelectric Voltage coefficient. Finally, the altered analytical model would be compared with COMSOL simulations and use cases.

At the outset the student need to understand the complex phenomenon of micromagnetics for magnetoelectric devices and their governing principles. He has to derive analytically the output parameters formulating the relevant equation of motions for transient states of the micro-scale devices. He has to use state of the art simulation tools to derive different parameters emanating from transient states of various topologies to validate the results of his analytical models within the project duration.

To complete this work the accuracy of this model needs to be tested. The model would be used to compute values for the voltage output of 3 devices that have previously been experimentally tested. These 3 use cases would be:

- An ME Transducer
- An ME Antenna
- An ME Magnetic field Sensor

Next the results of the model would be compared with the results of COMSOL simulations to see how accurate the model is at predicting the experimental results of devices.

References for an overview of the area:

1) J. Phys. D: Appl. Phys. **51** 263002 (2018) https://doi.org/10.1088/1361-6463/aac60b; A review on applications of magnetoelectric composites: from heterostructural uncooled magnetic sensors, energy harvesters to highly efficient power converters; Chung Ming Leung , Jiefang Li, D Viehland and X Zhuang
2) Journal of Applied Physics **103**, 031101 (2008); Applied Physics Reviews—Focused Review; https://doi.org/10.1063/1.2836410; Multiferroic magnetoelectric composites: Historical perspective, status, and future Directions; Ce-Wen Nan, M. I. Bichurin, Shuxiang Dong, D. Viehland, and G. Srinivasan