# A Novel Computational Solution to Advance Ferromagnetic NanoTherapy to Cure Cancer

Nabil, Tasnia (School: Vincent Massey Secondary School)

Cancer is a disease where mutated cells often clump together to form a tumor. Current oncological treatments include chemotherapy and radiotherapy, which often harm healthy tissue and have detrimental side-effects. Magnetic fluid hyperthermia is a promising cost-effective cancer treatment that uses magnetic nanoparticle (MNP) oscillations from an external alternating magnetic field to generate localized heating that destroys cancer cells with minimal effects on healthy tissue. However, this therapy lacks development due to its complex thermometry. To solve this problem, this interdisciplinary project proposes Ferromagnetic NanoTherapy, a novel computational solution that provides a powerful visualization tool to determine the required heat generation in a tumor for an optimized treatment. An interactive mathematical model was created on Python to calculate the magnetic thermal power based on the Neel and Brownian motion of the MNPs, magnetic field intensity, and MNP diameter and volumetric ratio. A 3D tumor Finite Element Analysis (FEA) model was created on ANSYS, where surrounding tissue and MNP injection site were defined with their respective thermophysical properties. A Computational Fluid Dynamics (CFD) model was developed to analyze the effects of blood perfusion on the MNP temperature distribution using Penne's Bioheat Equation in ANSYS FLUENT. A small-scale prototype to generate the magnetic field was built with optimized parameters based on the mathematical model, and experimentation concurred with the FEA results. Overall, Ferromagnetic NanoTherapy allows the physician to determine the thermal dose required to advance magnetic fluid hyperthermia into routine clinical applications for a sustainable cancer treatment.

**Awards Won:**

Fourth Award of $500