BIOGRAPHICAL SKETCH

Nastasia Allred was born and raised in Celina, TN where she attended Clay County High School. She graduated from Tennessee Technological University with a Bachelor of Science in Chemical Engineering with a Bio-molecular concentration in May 2015. Nastasia joined Tennessee Tech as a graduate student in the Fall of 2015 and joined Dr. Pedro Arce's research group. Her current research interests include mathematical modeling, healthcare applications, transport phenomena, and related pedagogical aspects. Ms. Allred has presented widely in national and international conferences including the Annual Meeting of the American Institute of Chemical Engineering (AIChE), the American Society of Engineering Education (ASEE) and the International Remediation (EREM) Meeting (Montreal, Ca). She is the winner of the 2018 AIChE Computer and System Technology Division Award for her contribution to the use of ISM in Health Care Applications among other University, College of Engineering and Department of Chemical Engineering distinctions. Also, Nastasia obtained her Master's of Science in Chemical Engineering in the summer of 2019.

EDUCATION

PhD Engineering
Tennessee Technological University, 2015-2020 (Expected)

M.S. Chemical Engineering
Tennessee Technological University, 2019

B.S. Chemical Engineering w/ Bio-molecular Concentration
Tennessee Technological University, 2015

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College of Engineering

TENNESSEE TECH

The Department of

Chemical Engineering

Announces the Dissertation Defense of

Ashley Nastasia Allred

In Partial

Fulfillment of the Requirements

For the degree of

Doctor of Philosophy in Engineering

April 8, 2020

10:30 AM CDT

Held on

Zoom: https://tntech.zoom.us/j/958065222

Meeting ID: 958-065-222

FIELD OF STUDY

Mathematical & computational modeling, healthcare applications, transport phenomena, chemical engineering

DISSERTATION TOPIC

Integral-Spectral Methods Applied to Healthcare Engineering: Fundamental Principles, Formulation, and Applications to Selected Healthcare Problems

EXAMINING COMMITTEE

Dr. Pedro E. Arce (Chairperson)

Dr. J. Robby Sanders (Co-Advisor)

Dr. Joseph J. Biernacki

Dr. Yung-Way Liu

Dr. Melissa Geist

ABSTRACT

There is a family of challenges associated with health care applications including the treatment of cancer tumors by hyperthermia, the down-scaling of dialyzers so that they can be patient-portable or implantable, and the diagnostics and treatments of kidney filtration malfunction that requires of an accurate description of their behaviors. The current available computational power and numerical approaches make it possible to tackle these challenges and produce a solution. However, when it comes to assist medical doctors with a proper predicted protocol for the treatments, time and the mobility of the computer-based device become important variables to consider and, therefore, current approaches to obtain such behaviors are not enough. Also, in general, problems in healthcare often consist of very complex systems due to multiple domains, various phenomena simultaneously occurring in said domains, and heterogeneity of characteristics such as tissue density, thermal conductivity, diffusivity, etc. These complexities make it very difficult to model problems in healthcare and thus an approach with the capability to handle these aspects is necessary. Integral-Spectral Methods (ISM) is an advanced mathematical-computational approach composed of two key components: operator-theoretic methods and integral equation approaches. This combination allows for handling of complex problems in engineering by decoupling the linear aspects (i.e. transport-based terms) and the non-linear aspects (i.e. kinetics/generation-based terms), and this ability of ISM makes it a methodical approach which is applicable to a hierarchy of problems. Furthermore, ISM has the potential of being amenable to be optimized and down-scaled to a hand-held device making such methods extremely appealing to assist medical doctors with predictions in a “real time” framework and extremely flexible to different situations encountered in health care applications such as those indicated previously. This doctoral research project focuses on the formulation and implementation of ISM to three systems in healthcare – hyperthermia treatment of cancerous tumors, dialysis treatment, and kidney filtration.