STAR Summer Camp: 3D-Fabrication for Medical Applications

- **Professor: Dr. Roozbeh (Ross) Salary,** *Mechanical and Biomedical Engineering*
- **Aims:** The aim of the project is to identify significant design and manufacturing factors thatlead to the fabrication of bone scaffolds with optimal functional properties.
- **Grade:** 12 (Fundamental background in mathematics, physics, and programming)

Faculty Profile:

Dr. Salary is an Assistant Professor of Mechanical and Biomedical Engineering at Marshall University. He is a holder of a Ph.D. degree in Industrial and Systems Engineering - Advanced Manufacturing in addition to Master's degrees in Mechanical and Chemical Engineering. His current areas of research include Biomedical Fabrication, Tissue Engineering, Regenerative Medicine, and Artificial Intelligence. For further information, please visit Dr. Salary's faculty profile at: https://www.marshall.edu/cecs/profile/dr-roozbeh-ross-salary/.

Project Description:

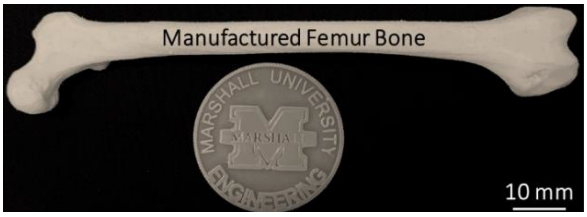

Figure 1: An X-ray μ-CT-based, biocompatible femur bone model fabricated at Marshall University.

This project focuses on design, 3D-fabrication, and characterization of bone scaffolds, composed of polymer materials, fabricated using material-extrusion additive manufacturing (AM) process. Material-extrusion has emerged as a robust high-resolution AM method for the fabrication of a broad range of biological constructs and structures. However, the material-extrusion process is inherently complex, governed by physical phenomena (such as repeated polymer fusion and solidification) as well as a wide range of factors and interactions. Hence, investigation of the effects of influential factors in the material-extrusion process would be an inevitable need. The research objective of this project is to identity significant material, scaffold design, and fabrication factors that influence the mechanical and functional properties of fabricated bone scaffolds. This will be done based on a systematic investigation of the significant factors via various experimental designs with the aim to unveil influential material-process-property relationships. The educational objective of the project is to help students gain hands-on lab experience and demonstrate an understanding of 3D-fbrication and academic writing.

As detailed in Table 1, this project is composed of four phases, as follows: Phase 1 is based on a comprehensive review of literature to identify the project gaps in addition to an introduction to the fundamentals of 3D-fabrication. Phase 2 includes scaffold design and 3D-fabrication of bone scaffolds with the aim to identity optimal material deposition and fabrication regimes. Phase 3 includes conducting a broad range of scaffold characterization experiments in addition to data analysis, interpretation, as well as drawing conclusions. Finally, Phase 4 will focus on preparation and submission of a project report and presentation. There will be weekly exams meant to measure the outcomes of the project activities.

Weekly Activities Description:

Week	Task	Outcome
1	Literature review and an introduction to the fundamentals of 3D-fabrication.	Identification of the project gaps and demonstration of an understanding of material extrusion AM process.
2	Experimental designs and fabricationof bone scaffolds.	Identification of optimal material deposition and fabrication regimes.
3	Characterization, data analysis, and data interpretation.	Identification of significant material-process-property relationships.
4	Preparation of a project report and presentation.	Understanding the fundamentals of academic writing and presentation.