CSAM Module III for MEEN 335 –Materials Processing

Cybersecurity in Additive Manufacturing (AM): Threats to Materials Properties and Performance

Unit Description: CSAM Module III advances CSAM activities to the system level as mechanical engineering students relate understanding of material processing concepts, such as solidification and temperature effects, to understand the relationship between operational parameters on the material properties and performance of AM printed parts. Further, students will analyze the potential effects of cyberthreats on materials properties and performance of AM printed parts. VR tools will be used to help students visualize physical concepts related to materials properties and product performance.

References: All materials for this module will be available on Moodle for students in Materials Processing classes.

Prerequisites by Topic:

1. Knowledge and understanding of Cybersecurity for Additive Manufacturing (CSAM) basics.

   Students who were not exposed to CSAM content in Freshman Engineering I (ENGR 120) or Intro to CADD (MEEN 252), or those who want a refresher should view the videos on the CSAM project website at www.subr.edu/page/ENGR120_CSAM.

   - ***From Visualization to Realization*** provides an overview of engineering graphics with introduction to graphics for engineering design, overview of additive manufacturing for engineering design, and introduces the necessity for cybersecurity in the AM process. The video ties engineering graphics to visualization using VR, cybersecurity using VR and presents the concept of visualization and spatial reasoning (computational thinking skills) as key to realization of engineering design and development of engineering ability.
   - **Additive Manufacturing and Cyber Security** videos introduce basic concepts of the 3D AM printing process and general cybersecurity issues

   Learning Assessment: Quiz (Moodle – completion credit): Knowledge of key terminology and understanding of connections between key concepts from the videos.

2. Understanding of materials properties and parameters, such as strength, ductility, stress, strain, fatigue, crystal structures, anisotropy, etc.
3. Understanding of materials processes and mechanisms, such as deformation, mechanical testing, solidification, strengthening, etc.

Module Objectives:

Students will demonstrate:

1. Understanding of how materials science and processing fundamentals relate to AM process operating parameters by identifying
2. Ability to apply understanding of materials science and manufacturing processes to calculate or test properties of AM products.

Student Learning Outcomes:

Upon completion of this unit, students will have the ability to:

1. Compare and contrast conventional materials processing methods with operational parameters of AM devices.
2. Calculate or determine properties affecting performance of AM products to identify and/or characterize potential cyberthreats.

Module Educational Strategies:

1. Provide opportunities to learn the module materials through videos.
2. Provide opportunities to employ VR technology to visualize physical concepts related to materials properties and product performance in a case study.
3. Provide opportunities to work in teams to apply course content knowledge to analyze a case study of a real-world application involving CSAM.

CSAM Module III will be covered in two (2) weeks.

Module Contents and Activities:

Activity	Topic
1	Materials properties, processing, and manufacturing parameters in AM systems.

The material properties and performance of AM printed parts depend on the equipment parameters, such as type of feed stock (polymer or metal type and composition, or form such as powder or filament) and settings, such as print speed, print temperature, print orientation, etc. Supplied videos examine examples of how such parameters affect the quality and performance of printed parts. Assigned for viewing outside of class.

Learning Assessment: Quiz (Moodle – 20 points): Knowledge of key terminology and understanding of relationships between/among key concepts from the videos and/or assigned readings.

2 Cybersecurity for Additive Manufacturing

Case Study: dr0wned – AM Cyber Attack. Video (www.subr.edu/page/ENGR120_CSAM)

Learning Assessment: Students will work in teams to visualize and analyze how the cyber attack altered properties (such as strength, fatigue resistance) leading to failure of the printed assembly (Application and analysis – project oral presentation and written report, including computational analysis of performance).