MATSCEN 5655 (Approved): Biomedical Device Additive Manufacturing

Course Description

Survey of Additive Manufacturing (AM) patient data acquisition and medical device Computer Aided Design (CAD), medical research and clinical grade AM materials and AM fabrication methods, quality assurance/management systems and regulatory (FDA) approval process.

Transcript Abbreviation: Biomed Add Manuf
Grading Plan: Letter Grade
Course Deliveries: Classroom
Course Levels: Undergrad, Graduate
Student Ranks: Junior, Senior, Masters, Doctoral
Course Offerings: Autumn
Flex Scheduled Course: Never
Course Frequency: Every Year
Course Length: 14 Week
Credits: 3.0
Repeatable: No
Time Distribution: 3.0 hr Lec
Expected out-of-class hours per week: 6.0
Graded Component: Lecture
Credit by Examination: No
Admission Condition: No
Off Campus: Never
Campus Locations: Columbus
Prerequisites and Co-requisites: MATSCEN 3141 or BIOMED 4310 or ISE 2500 or Graduate standing in MGEL, MATSCEN, WELDENG, BME, CBE, MAE, or ISE; or permission of instructor.
Exclusions:
Cross-Listings:

Course Rationale: Background in the design, materials, fabrication, and regulatory considerations when using

Additive Manufacturing to manufacture biomedical devices.

The course is required for this unit's degrees, majors, and/or minors: No
The course is a GEC: No
The course is an elective (for this or other units) or is a service course for other units: Yes

Subject/CIP Code: 14.9999
Subsidy Level: Doctoral Course

Programs

Abbreviation	Description
MATSCEN	Materials Science and Engineering

Course Goals

Understand the requirements of 3D patient data acquisition, patient-specific CAD and mechanical modeling (i.e., Virtual Surgical Planning), and intra-operative guidance.
Understand how 3D fabrication technologies are used in biomedical research.

Understand how 3D fabrication technologies are used in the clinic.
Understand range of criteria used to design, validate, and use biocompatible, 3D printable, materials.
Understand basics of the regulatory process including Quality Assurance (QA) and/or Quality Management Systems, GLP assessment, and GMP production.

Course Topics

Topic	Lec	Rec	Lab	Cli	IS	Sem	FE	Wor
Block I: Data Acquisition and Design (5 lectures) Lectures 1-2: Overview; 3D image acquisition and processing (slice and surface scanning); medical and industrial imaging	3.0							
Block I Lectures 3-4: 3D image preparation for 3D printing (CAD); Mechanical Modeling for biological applications	3.0							
Block I Lecture 5: file set up for 3D printing	1.5							
Block II: AM Processes for Biomedical Devices (7 lectures) Lectures 6-8: Polymer: Fused Deposition Modeling, Binder Jetting, Selective Laser Sintering, and Powderbed Fusion for Medical Applications.	4.5							
Block II Lectures 9-10: Electrospinning, Melt Electrowriting, vat photocrosslinking: stereolithography and projection (mask) printing; Hydrogel bioprinting and bioassembly	3.0							
Block III: Fabrication and Applications of AM Biomedical Devices (9 lectures) Lectures 13-15: FDM, Binderjetting, and SLS Applications	4.5							
Block III Lectures 16-19: Electrospinning, Melt Electrowriting, Vat Photocrosslinking, Hydrogels for Bioprinting and Bioassembly, Cells, Spheroids, and Organoids.	6.0							
Block III Lectures 20-21: Powderbed Fusion Ceramics and Metals	3.0							
Block IV: Regulator of AM Biomedical Devices (7 lectures) Lectures 22: biocompatibility in vitro (cytotoxicity) and in vivo (small animal models)	1.5							
Block IV Lectures 23: large animal models	1.5							
Block IV Lectures 24: FDA (Presubmission, IDE, IND, 510k, PMA)	1.5							
Block IV Lecture 25: Translation to the Clinic	1.5							

Representative Assignments

ConcepTests designed to gauge/improve student knowledge on a peer-to-peer basis

Selected homework problems from text

Grades

Aspect	Percent
Quiz	20%
Mid-term Exam	25%
Project	30%
Final	25%

ABET-EAC Criterion 3 Outcomes

Course Contribution		College Outcome
**	a	An ability to apply knowledge of mathematics, science, and engineering.
*	b	An ability to design and conduct experiments, as well as to analyze and interpret data.
***	c	An ability to design a system, component, or process to meet desired needs.
**	d	An ability to function on multi-disciplinary teams.
**	e	An ability to identify, formulate, and solve engineering problems.
*	f	An understanding of professional and ethical responsibility.
*	g	An ability to communicate effectively.
	h	The broad education necessary to understand the impact of engineering solutions in a global and societal context.
*	i	A recognition of the need for, and an ability to engage in life-long learning.
*	j	A knowledge of contemporary issues.
***	k	An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

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