VME 6071C - Medical 3D Printing
Fall Semester 2023 – University of Florida

1. **Catalog Description:** Medical 3D Printing (3 Credit Hours) This course will cover the application of 3D printing technologies in the field of medicine. It will cover subjects from image acquisition with the correct parameters, image processing, image mask creation, importing to 3D software, manipulation in the 3D environment and exporting the file for successful 3D printing. This will cover a large number of mechanical and biological considerations for repair and replacement of soft and hard tissues and joints. Fracture fixation, orthopaedic implants for hip and knee, orthotic and prosthetic devices are all included in the design portion of the course.

Prereq: undergraduate mechanics of materials, statics, dynamics, kinematics, MATLAB.

Course Objectives:

- Understand the fundamental principles and workflow for additive manufacturing in the medical field, from CT Scans to 3D printing and the processing of a final product
- Acquire the vocabulary necessary to navigate the complex, multivariate landscape of additive manufacturing equipment, materials, and applications used in medicine and surgery.
- Learn to identify how, when, and where 3D printing in medicine can create value to the MD/DVM, from design concepts to end-of-life; and how to select a 3D printing process and material for a specific application.
- Acquire the skills to know how to acquire 3D volumetric images for importation into 3D software
- Acquire the ability to segment, manipulate, alter mask of anatomical regions
- Acquire the skills necessary to design parts for medical 3D devices that combine engineering intuition with computationally-driven design and process-specific constraints.
- Develop a cutting-edge perspective on using 3D models to help patient outcomes.
- The student should gain a detailed understanding of the engineering and technologies used in the study of 3D models for biomechanics *in silico*.
- The student should understand how to apply a spectrum of measurement techniques to provide quantitative assessment of clinically relevant motions, forces and actions.
- The student should understand basic mechanical considerations in the selection or development of surgical procedures and implanted orthopaedic devices.
- The student will gain experience in critical review of the medical/ biomechanical/ 3D printing literature.
- The student will gain experience in the presentation of research findings with critical commentary and extemporaneous discussion.

Course Co-Ordinator: Adam H Biedrzycki, DVM, PhD, DACVS

      Office location: VH-124
      Telephone: 352-294-4339
      E-mail address: dradam@ufl.edu
      Class Web site: e-learning portal
      Office hours: 11:45am - 12:35pm W in VH-124

Instructors:

TBD

2. Meeting Times: MWF 2nd period – 8:30am-9:20am
    a. MW will be classroom based
    b. F will be computer lab based

3. Class schedule: Three 50 minute classes per week

4. Meeting Location: Deriso Hall, Conference Center

5. Material and Supply Fees: Download MIS Student software to be installed on a PC.

6. Textbooks and Software Required – There are no required texts. All reading materials will be provided online at the class web site. Students will need access to Materialize MIMICS and 3 MATIC software (available at the computer center or online)

7. Recommended Reading: Reading is assigned on a per class basis, and all readings are posted on the Canvas web site.

8. Course Outline: This is a ROUGH outline of the topical flow of the course. The instructor will, at his sole discretion, modify the schedule and content of the course to complement the research and professional interests of the enrolled students:

    a. Weeks 1-3 - Introduction to 3D Printing in Medicine
    b. Weeks 4-6 – CT Image Acquisition and Mask creation
    c. Weeks 7-8 – Manipulations in the 3D Environment
    d. Weeks 9-10 – Virtual Surgical Planning
    e. Week 11 – 3D Printing and Troubleshooting
    f. Weeks 12-13 Evaluating Model Testing and New Iterations on Design
    g. Weeks 14-15 Final Project presentation and conclusions

9. Attendance and Expectations – Students are expected to attend class. A substantial part of the student's grade, and the value of the class, will be derived through participation in the class sessions. All written assignments are to be handed in online (in Canvas) before the beginning of class on the date due. **No late assignments will be accepted.**

10. Grading:
    a. Homeworks and in-class quizzes   20%
    b. Exams (3)   40%
    c. Class Presentations & Participation   10%
    d. Term Project   30%

11. Grading Scale (90-100 A, 88.0-89.99 B+, 80.0-87.99 B, etc.) Grades will not be curved. If you do not agree with the grading of a particular exam or homework problem, presentation grade, or project grade, you will have one week from the date the grade is assigned to submit a written explanation of why you think the grade should be higher. However, the final decision will remain the instructor.

12. Make-up Exam Policy – If the student is unable to take an in-class quiz or complete an assignment due to documented illness, suitable arrangements will be made for the student to complete the work for full credit. If the student is unable to attend class because of planned travel, the student is responsible to make alternate arrangements a minimum of two weeks in advance of his/her absence to complete the assigned work.

13. Course web site. Students will be expected to check it on a regular basis for up-to-date course information. This may include changes to the syllabus, homework assignment due dates, and exam schedules. The course web site will be accessible from the UF E-learning web site at lss.at.ufl.edu.

14. Class E-mail List. We will use the Canvas course page for communications in the class.

15. Personal responsibility. You are personally responsible for all information disseminated during the lectures. This means knowing all homework due dates, knowing when exams will be given, where they will be given, what material they will cover, and knowing all material, handouts, and announcements made in the lectures, whether or not you were present. Thus, if you miss a lecture, it is your responsibility to obtain all information presented during that lecture. "I missed that information" or "I was unaware of that information" will not be accepted as valid excuses.

16. Workload. 3D medical printing covers a wide range of engineering techniques and technologies, anatomy, pathology, design and analyses. The goal of this course is for you to be at least conversant and familiar with several key areas within the field. In addition to the intellectual content, this course will strongly emphasize the development of presentation skills and critical review of technical literature. A considerable portion will be working through the tasks using the computer software. Plan to spend at least two hours outside of class for each hour of class time in order to complete the readings, homework and prepare for quizzes and presentations.

17. Project. At the beginning of the class, you will each be given a different set of CT images with a brief clinical history of a problem that has a 3D printing solution. It will be your class project to segment, create, print, test, evaluate, and redesign your

device to optimize it for medical purposes.

18. Honesty Policy – All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is a reminder to uphold your obligation as a UF student and to be honest in all work submitted and exams taken in this course and all others.

   Violations of the honestly policy will be handled strictly according to U.F. policy. The minimum penalty for an honesty violation will be a one letter-grade reduction for the course.

   Ask at any time if you are unclear whether work is to be performed individually or collaboratively.

   Failure to properly cite reference material, whether from scientific articles, books, theses, or web sites is plagiarism, which is a violation of academic honesty. Ask at any time if you have any questions on how properly to cite work that is not your own.

19. Accommodation for Students with Disabilities – Students Requesting classroom accommodation must first register with the Dean of Students Office. That office will provide the student with documentation that he/she must provide to the course instructor when requesting accommodation.

20. UF Counseling Services – Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:
    - University Counseling Center, 301 Peabody Hall, 392-1575, Personal and Career Counseling.
    - SHCC mental Health, Student Health Care Center, 392-1171, Personal and Counseling.
    - Center for Sexual Assault/Abuse Recovery and Education (CARE), Student Health Care Center, 392-1161, sexual assault counseling.
    - Career Resource Center, Reitz Union, 392-1601, career development assistance and counseling.

21. Software Use – All faculty, staff and student of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Tentative Class Schedule

Week	Date	Lecture/Presentation		
		Monday	Wednesday	Friday
1	28 Aug -	Syllabus and Projects	Historical Background and Applications Overview of Equipment +Processing Data	Review Material
2	4th Sept -	LABOR DAY (No class)	Overview of CT/MRI	Literature Review
3	11 Sept -	How to move data	Importing Data to Mimics Creating Masks in Mimics, Editing Masks (Heather Roe)	Review CT data (Computer Lab), Exercise 1: Mask Creation (Computer Lab)
4	18 Sept -	Boolean Functions, Mask Optimization, Wrap and Smooth Functions	Advanced Mimics Functions	**Exercise 2: Editing Masks** (Computer Lab)
5	25 Sept -	Importing masks to 3-Matic	Working in the Virtual Environment	Analysis Techniques in 3-Matics
6	2 Oct -	Trim, Cut, Boolean Operations in Mimics	**EXAM 1: Mimics** (Computer Lab)	NO CLASS (Homecoming)
7	9 Oct -	Optimizing for 3D Printing	New Medical Equipment Design	**Exercise 3:** Using 3-Matic (Computer Lab)

8	16 Oct -	VSP 1 Drill Guides, Reduction Guides (Christina DeArmond)	Cutting and Reduction Guides Guides (Lindsay Peterson)	**Exercise 4:** Advanced 3-Matic Functions, Virtual Surgical Plans, Drill and Cutting Guides (Computer Lab)
9	23 Oct -	Clinical Correlations (Stan Kim)	Insight Functions	**Exam 2: 3-Matic** (Computer Lab)
10	30 Oct -	Sending models to printer, printer troubleshooting	Printing Materials	**Exercise 5:** Project work
11	6 Nov -	PRINTER EXAM (Group A)	PRINTER EXAM (Group B)	**No Class – Veterans Day**
12	13 Nov -	Evaluating Surgical Models, Sterilization of 3D objects	2nd Iterations Designs	**Exercise 6:** Final Project Compilation
13	23 Nov -	Presentation of Cases	**THANKSGIVING**	**THANKSGIVING**

*Please note that the instructor reserves the right to alter the syllabus/schedule if it is determined that such a change will benefit the course and the students. This syllabus is intended to give the student guidance in what may be covered during the semester and will be followed as closely as possible. However, the professor reserves the right to modify, supplement and make changes as the course needs arise. This includes exam dates and lecture topics that may change depending on class progress.