

## 1 Description

Fundamentals of design, prototyping, and entrepreneurship for all disciplines. Introduction to machine elements and metrology to facilitate the design process. Practical aspects of Computer Aided Design (CAD) for creating parts, assemblies, and mechanical drawings. How to select and 3D print a polymer for a specific application. Foundational skills for incorporating digital logic into prototypes, including electrical wiring and microcontroller programming. Students will have the opportunity to print their own prototypes and iterate on their designs.

## 2 Class Meeting Times and Location

Tuesday/Thursday:

Location:

## 3 Instructors

**Instructor of Record:** Dr. David Florian

**Email:** David.C.Florian@Vanderbilt.edu

**Office:**

**Office Hours:**

## 4 Textbooks, Software, and Instruments

- No textbook is required for this course.
- A laptop running Windows or macOS is required with a USB-A port connection (a Type-C to Type-A adaptor may be required).
  - A computer is available in the Digital Fabrication Lab for student use if needed. Computer issues are not excusable.
- Fusion 360 is required but free for students.
  - Fusion 360 license and installation guide: [autodesk.com/fusion360edu](https://autodesk.com/fusion360edu)
  - Enroll in an educational license - **not** the free trial.
- Digital calipers are required (\$20): <https://amzn.to/3Kb0JtW>

## 5 Flipped Classroom and Asynchronous Learning

DF 2100 leverages traditional lectures, flipped classroom learning, hands on projects, and asynchronous content to teach the fundamentals of prototyping. Asynchronous content is a useful tool when teaching students with diverse intellectual backgrounds. For those unfamiliar with a topic, the content can be viewed and referenced as many times as needed. Asynchronous content will be posted to BrightSpace.

## 6 Attendance, Asynchronous Lectures, and Late Work

This class features both in-person lectures and asynchronous material. Participation is required for in class activities and labs. If a student plans to be absent from graded in-class assignments, then the professor must be notified at least 48 hours in advanced. Rescheduling a makeup or excusing the student from the assignment is at the discretion of the professor. Doctor appointments and athletics are excusable absences but require proper documentation.

It is expected that students watch asynchronous content in a timely manner. The online CAD lectures each correspond to a class day. Information regarding upcoming assignments and due dates will be discussed

in these videos and/or on BrightSpace. Failing to submit these assignments because the asynchronous content was not viewed at the appropriate time is not a valid excuse.

Students are afforded a 3-day grace period to submit one of the following assignments past the due date without penalty:

- CAD Projects (1-4)
- 3D Printing Project
- LED Wiring

Professor Florian must be notified over email within this 3-day window to claim this opportunity.

Late work (outside of the 3-day grace period) or failure to attend a required in class assignment will result in a 0. Disputes regarding graded assignments must be brought to Professor Florian within a week of receiving the grade.

## **7 3D Printing**

Assignments that rely on 3D printing should be started early as filament printing does not have a 100% success rate and large prints can take over a day. Further, the Digital Fabrication Lab does not have the capacity for all students to wait until last day. The due dates for any assignment involving 3D printing have been set to account for print failures and the number of students enrolled in the class. Print failures and busy printers are not valid excuses for late work. *Students who begin their work early are more likely to succeed.*

## **8 Digital Fabrication Lab Access and Lab Breakage Fees**

The Digital Fabrication Lab (DFL) is open Monday - Friday from 10 am to 5 pm. Additional times may be provided during the 3D printing project and syringe pump project. Students are expected to act professionally and safely in the DFL. Food and drinks are not allowed. Attempting to operate equipment that students are not trained on by Professor Florian is not permitted. All hand tools, components, parts, etc. cannot be borrowed or removed from the DFL. Failure to abide by these rules will result in the revoking of access to the space, which will prevent passing of this course.

To prevent a course-specific fee paid by all students enrolled in DF-2100, supplies and equipment must be reused between sections and semesters. Intentional misuse of supplies and equipment or gross negligence that results in damage will incur a breakage fee, which is payable by replacing the component in a timely manner.

## **9 Communication**

Outside of lecture, Professor Florian will communicate with the class through BrightSpace announcements and emails. Be sure to turn on notifications as to not miss any pertinent information. Office hours should be used to ask questions and seek additional help on assignments. Email may not be answered after business hours (M-F, 9a-5p).

## **10 Accommodations**

Vanderbilt is committed to equal opportunity for students with disabilities, as am I, your instructor. If you need course accommodations due to a disability, please contact [VU Student Access Services](#) to initiate the process. Rapid Prototyping (DF-2100) is a non-traditional course without formal in class examinations. Please preview the assignments below and/or schedule a meeting with Prof. Florian to discuss how VU-

approved accommodations would apply to this course. Accommodations must be discussed prior to the due date of an assignment.

## **11 Honor System**

All students are expected to abide by Vanderbilt University's Honor Code. These expectations include the application of academic integrity and honesty in your class participation and assignments. *Students are not permitted to reference past work from students, including reports, 3D models, and examination material. Students may not download 3D model from online and claim them as their own.* Further, AI generated text is not permitted for project reports.

## **12 Group Work**

For the final project, students are tasked with working in groups to build a functioning prototype. Professor Florian will form intellectually diverse groups (e.g., different majors and years) to model what students will likely encounter in the industry. Teamwork skills, such as communication, time management, and leadership, are critical for the success of the project. To evaluate each group member's contribution, students will fill out a peer evaluation at the completion of the project. In the rare case where a group member is absent or unmotivated, please communicate with them over email with Professor Florian CC'ed. Failing to contribute to or work cordially with your group will result in a lower individual project grade at the discretion of Professor Florian.

## **13 Assignments and Grade Composition**

Fits and Tolerances (Brightspace) - 5%

- Short open-note assessment on calculating different types of fits and explaining the importance of tolerances.

Measurement Practical - 10%

- Practical examination on measuring with common metrology tools (calipers, micrometers, telescoping gauges, and thread gauges).

Computer Aided Design (CAD) - 20%

- CAD Project I (3.3%) - Widget modeling
- CAD Project II (3.3%) - Dimensioned Drawing
- CAD Project III (3.3%) - 3D model of flexible coupler
- CAD Project IV (10%) - Linear actuator assembly

3D Printing Project - 15%

- Students will 3D Print a phone case out of TPU and iterate on their design. A small report will be submitted on the extent that filament-based printers are able to reproduce digital models.

3D Printing Practical - 10%

- Practical examination on slicer settings and troubleshooting common 3D printer problems. Short quiz on the anatomy of a 3D printer, functionality of components, and material selection for different applications.

#### Safety Quiz: 5%

- Electrical wiring presents many invisible hazards that can lead to electrocution or fire. It is critical to understand how to safely wire components together. This quiz will test in class material and asynchronous learning.

#### LED Wiring: 5%

- Assessment on soldering and crimping technique.

#### Microcontroller Programming Quiz: 5%

- Assessment on UI and methods of programming an Arduino in the IDE

#### Syringe Pump - 20%

- Students will work in groups to design, 3D print, build, and program a syringe pump that is capable of dispensing microliter volumes of fluids. A working physical and digital assembly are required in addition to a product report.

#### Syringe Pump Peer Evaluation - 5%

The final grade will be a computed from the weighted averages of all assignments. A letter grade will be assigned based on the following scale: **A** = 100-93, **A-** = 92-90, **B+** = 89 - 87, **B** = 86 - 83, **B-** = 82-80, **C+** = 79-77, **C** = 76-73, **C-** = 72-70, **D+** = 69 - 67, **D** = 66-63, **D-** = 63-60, **F** = below 60

## 14 Course Schedule

NO.	DATE	TOPIC	ASSIGNMENT DUE
Part 1: Design, Measurements, and CAD			
1	8/24	Introduction to Rapid Prototyping and Digital Fabrication	
2	8/29	Metrology	
3	8/31	Fasteners	Fits/Tolerances
4	9/5	Machine Elements	
5	9/7	Measurement Instrument Practice	Online Videos
6	9/12	Measurement Instrument Practice	
7	9/14	Measurement Practical	In-Class Assessment
8	9/19	CAD Basics (with asynchronous content)	
9	9/21	CAD Basics (with asynchronous content)	CAD Project I
10	9/26	CAD Basics (with asynchronous content)	CAD Project II
11	9/28	CAD Basics (with asynchronous content) - <b>Online Only</b>	CAD Project III
12	10/3	CAD Basics (with asynchronous content)	
Part 2: 3D Printing			

13	10/5	Fundamentals of Additive Manufacturing and Filament Printing	CAD Project IV
14	10/10	Printable Materials and Recycling (Assign 3D Printing Project)	
15	10/12	FFF Lab 1	Slicer Video
16	10/17	FFF Lab 2	
	10/19	Fall Break	
17	10/24	FFF Lab 3 & 3D Printing Practical	In-Class Assessment
18	10/26	FFF Lab 4 & 3D Printing Practical	In-Class Assessment

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Part 3: Digital Logic

19	10/31	Electrical Prototyping	3D Printing Project
20	11/2	Electronics Lab: LED Wiring	Online Video & <b>Quiz</b>
21	11/7	Electronics Lab: LED Wiring	LED Due
22	11/9	Microcontrollers	
23	11/14	Electronics Lab: LED + Button	Online Videos
24	11/16	Electronics Lab: Stepper Motors and Actuators	Quiz

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Part 4: Syringe Pump Project

	11/21	Thanksgiving Holiday	
	11/23	Thanksgiving Holiday	
25	11/28	Syringe Pump Project	
26	11/30	Syringe Pump Project	
27	12/5	Syringe Pump Project	
28	12/7	Syringe Pump Project	
Final Exam Day:		Syringe Pump Demonstration	Syringe Pump Report

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